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SPINAL CORD SURGERY[1]

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IN an address before a general surgical society, it would seem appropriate to dwell on the various types of spinal cord lesions that may be benefited by surgical intervention and to discuss operative results rather than to dwell on the points in diagnosis on which the neurological surgeon, who does and ought to make his own neurological study, has to spend much time and consider with meticulous care. There will always be times when it will be necessary for the general surgeon to do a laminectomy, although I believe that the general surgeon feels about this branch of surgery almost as he does about cranial surgery—he now gladly turns over this work to the neurosurgeon. There is, of course one great difference—the operation of laminectomy is generally comparatively simple and one does not meet the technical difficulties with it that are encountered in a cranial operation. The diagnosis, however, offers many pitfalls, and it does not seem wise for a surgeon to be merely "the hands," which he must be if he has to depend on others for his diagnosis.

INDICATIONS AND TREATMENT

The conditions for which laminectomy may be required may be grouped under seven headings: (1) fractures and dislocations of the spinal column; (2) inflammatory processes, meningitis and abscesses or solitary tubercles; (3) compressions of the cord due to deformities; (4) spasticities due to inflammatory diseases, cerebral birth palsies, or old injuries; (5) spinal tumors; (6) relief of intractable pain, and (7) congenital defects (spina bifida).

The subject of fractures and dislocations with cord symptoms was discussed with some asperity before this organization several years ago when the subject was brought up by Dr. Coleman. It is universally agreed that when no spinal cord symptoms are present, such as spastic paralysis, sensory disturbances or bladder and rectal disturbances, the problem is merely to deal with the fracture or dislocation by putting it at rest, to institute supporting measures such as casts or braces, and occasionally to strengthen the back with a bone graft.

How about the cases, however, in which cord symptoms are present? These are of two kinds: those that present the picture of a complete block of the cord with complete motor and sensory paralysis, and those in which there is evidence that the cord is not completely blocked because the patients have some sensation below the level of the injury or some motor power, even if it be only the movement of a toe. In either group the disturbance may be due to pressure which causes an interference with function but there is no anatomical severance or there may be a partial or complete severance of the cord.

Suture of the cord does not lead to regeneration and restoration of function and is a useless procedure. A complete physiological

[1]Read before the Southern Surgical Association, Augusta, Georgia, December, 1927.

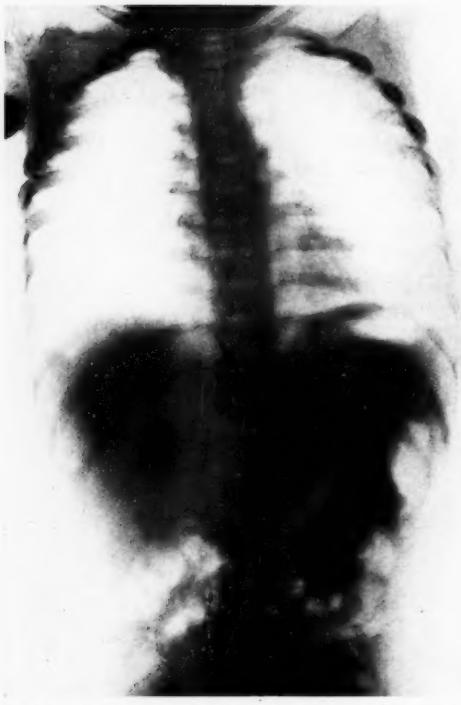


Fig. 1. The globules of lipiodol are caught between the eighth and eleventh dorsal vertebræ; none passed below this point. This was the level of the tubercle. On account of the age of the child, only 1 cubic centimeter of lipiodol was used instead of the usual quantity of 2 cubic centimeters.

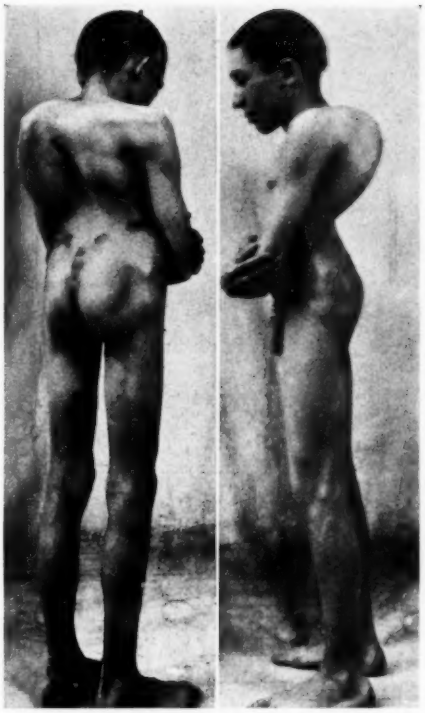
block of the cord cannot be distinguished clinically from an anatomical severance; the symptoms are identical—loss of all functions. If we wait to see if the cord will recover some function, as it may after a physiological block, we lose precious time, and irreparable permanent injury may be done by the pressure alone. Consequently, if these patients are to get relief at all they must have an early exploration. We all dislike to operate unnecessarily and have found the method suggested by Coleman some years ago of doing a spinal puncture and determining by jugular compression—the Queckenstedt test—if there is a block, to be a most valuable aid in diagnosis. If there is a spinal block, one should explore and do so early; if there is no block according to the Queckenstedt test, it is probably useless to operate, for in such cases the lesion is a pulpifying of the cord, for which operation can do no good. That is the principle I have been following in the past 18 months, but it is not improbable that that is too conservative an attitude to take. Since we know that it is possible that the Queckenstedt test may not be positive in the presence of compression of the cord by a spinal tumor it seems perfectly logical to assume that the same thing may happen in the presence of a fracture—there may be compression of the cord and yet the Queckenstedt be negative. In such cases operation is indicated. No doubt the pendulum will swing back to a point where some of these cases will be operated upon. If the picture of a partial block is present, operation should be done only if there is evidence of compression of the cord, as shown by the Queckenstedt test. Then, too, operation should be done early before secondary degenerative changes occur.

Abscesses of the cord or solitary tubercles present the picture of a focal spinal lesion and should be operated upon. I want to record a unique case that we had 2 years ago in an infant, age 20 months. The lower extremities were totally paralyzed and all reflexes abolished. The legs of the child were anæsthetic, but on account of the age of the child the upper level could not be determined. A lipiodol injection showed a complete block (Fig. 1). At operation a swollen cord was found and when it was incised a brownish mass the size of a peanut was readily enucleated. I thought that it was a dermoid but section showed it to be a solitary tubercle. The child made an excellent recovery at the time and learned to walk, but 18 months later died of pulmonary tuberculosis.

Meningitis due to a pyogenic organism is such a hopeless, desperate disease that anything that may reduce the mortality, which is close to 100 per cent, is justifiable; for that reason, when we see such cases early, we drain the lumbar region at the site of the third or fourth spinous processes. This operation was in recent years revived by Dr. William Leighton, and certainly deserves a trial. In 22 cases we have used this method and there have been 6 recoveries. That is a small percentage of recoveries but in view of the fact

that if it had not been done probably all of the patients would have died, it seems worth trying. Dandy has advocated drainage of the cisterna magna in preference to that of the lumbar drainage. Where there is no spinal block between the cisterna and lumbar region, I can see no advantage in draining at that point and, with the marked retraction so frequently present in a case of meningitis, the operation is technically more difficult and a more formidable procedure. If there is a local focus from which the meningitis originated that, of course, should be drained just as the appendiceal abscess must be drained if a spreading peritonitis is to be controlled. The two conditions, however, are not otherwise comparable, for in the subarachnoid space there is a fluid which is being constantly secreted in large quantities, while in the peritoneum the amount of fluid secreted is negligible. In favorable cases of meningitis which ultimately recover, I have seen the drainage continue for 6 to 8 weeks. Repeated spinal puncture does not accomplish the same thing, for between punctures the re-accumulating fluid tends to break up adhesion and spread over the cerebral cortex. Several of my meningitis cases followed operations on the nasal sinuses, by otolaryngologists, but in such cases drainage of the local focus is quite impossible and of no avail. In not all the cases of meningitis have organisms been found but in such cases the diagnosis was made on the clinical picture and the high cell count in the spinal fluid, varying from 600 cells up to thousands. Of the cases which resulted in recoveries, cultures showed the proteus vulgaris in one, the streptococcus in two, and the staphylococcus aureus in one. The question has been raised whether some of these cases in which organisms were not found might not have been sporadic cases of meningococcus meningitis. As all fluids were cultured and studied microscopically and as in no case intracellular diplococci were found, we feel that this possibility can be excluded.

Occasionally, we see cases of cord compression due to spinal deformity (Figs. 2, 3, 4). I reported such a case before the American Orthopedic Association in 1925. In that paper



Figs. 2 and 3. Spinal deformity which caused cord compression. Photograph taken about 4 weeks after operation.

it was pointed out that similar cases had probably been mistaken for compression due to a tuberculous lesion. Recently McKenzie, of Toronto, has reported a similar case. In his case, as in mine, the rapidity with which the patient recovered after the compression was relieved was extraordinary. My patient had been totally paralyzed for 11 months and had been unable to move any muscles of his legs during all that time, yet in 48 hours he began to move his legs and was walking 4 weeks after the operation. Undoubtedly, this condition is more common than would appear. As a rule, these cases are called tuberculosis and are not operated upon. Just what the pathological condition is, is uncertain. I feel quite sure, however, that not the lipomatous mass overlying the cord (Fig. 4) but the gibbus over which the cord is stretched is responsible for the symptoms.

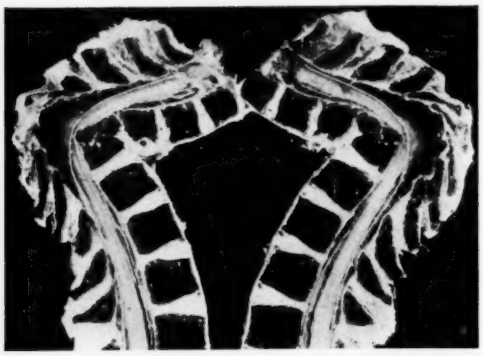


Fig. 4. Photograph of an autopsy specimen which was obtained from Dr. Ludwig Pick, of Berlin, about 20 years ago. It shows the identical condition that was found in my patient whose case I have reported. The big space between the cord and the bone was filled with fat. When the dura was opened the cord rolled out and the dura was left wide open.

Ample opportunity should be given a patient to recover under orthopedic measures from spinal cord compression in Pott's disease, but, if no improvement occurs after these methods have been given a fair trial, operation may very properly be considered. Just how long the conservative methods should be tried is a matter about which there is considerable difference of opinion. Ryerson recently has advocated operating after 6 months, if there has been no evidence of return of function. This seems a reasonable time to wait athough cases are recorded in which recovery occurred after paralysis had been present for a far longer time. When operation is performed, the spinal dura should not be opened if there is any evidence, as there usually is, of an extradural process, on account of the danger of starting up a tuberculous meningitis.

Spastic paraplegias without sensory disturbances have received much attention from the neurological surgeon. It is beyond the scope of this paper to go into the merits of the various operative procedures that have been used to relieve spasticity, since I am discussing only spinal surgery. The various procedures may be grouped under four headings: (1) operations on the tendons; (2) operations on the peripheral nerves; (3) operations on the posterior roots—the Foerster operation; (4) the Royle operation on the sympathetic. Each of the first three has its place in selected cases. The fourth, the Royle operation, is useless in the treatment of spasticity. The section and removal of the sympathetic does not affect muscle tone sufficiently, if at all, to be of any practical value. Since this paper is on spinal surgery, I shall speak only of the Foerster operation.

The so-called Foerster operation, the cutting of selected posterior roots intradurally, changes a spastic leg to a flaccid one in a most remarkable and striking way. I have done the operation in about 30 cases, but I have used it less frequently in recent years. I have learned that in the first place the after-treatment—massage and re-educational exercises—is of enormous importance. If it is not carried out for a long time, the improvement will not be maintained. Then, too, the after-treatment needs the intelligent co-operation of the patient, and many of the patients are children who are mentally deficient; if there is not enough mentality present to give one intelligent co-operation, the operation should not be undertaken.

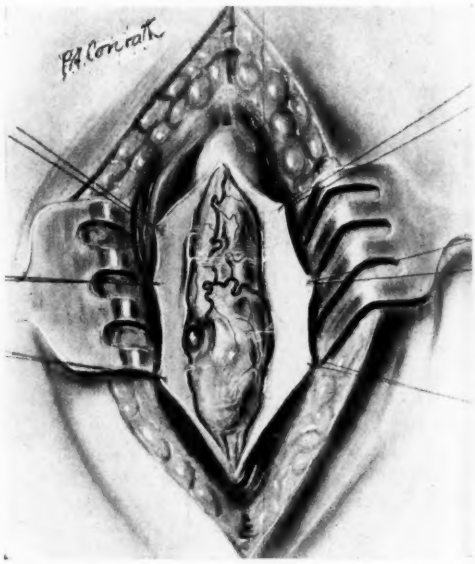


Fig. 5. Tumor of the filum terminale and terminal end of the cord.

In selected cases it still remains a most helpful procedure. It is a formidable operation. The roots should be cut at their exits from the canal, not at their origin from the cord. At the latter point it is impossible to identify the different roots and, as Foerster originally pointed out, it is very important to select the roots in such a way that each group of muscles will have some sensory supply left. Any operative procedure for spastic paraplegia, however, should not be undertaken until it has been determined what has caused the paraplegia, for spastic paraplegia is only a symptom, not a disease. Some years ago I removed an endothelioma from a girl who had been riding around in a wheel chair for 8 years, with a diagnosis of spastic paraplegia. The tumor had not only compressed the cord but had eroded one part of the body of the vertebra so that a tongue-like process extended into the posterior mediastinum. Its complete removal, however, brought no recovery in the legs as the cord had been permanently injured by prolonged compression. If no focal lesion can be found, then the Foerster operation may be considered for the relief of spastic paraplegia.

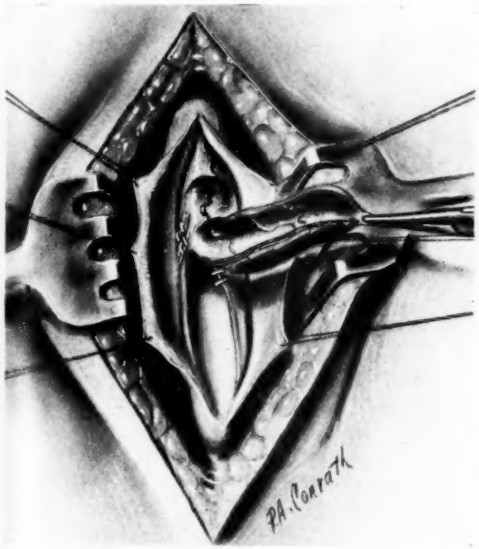


Fig. 6. Shows the tumor after it was partially lifted out of its bed. Patient has had no return of symptoms.

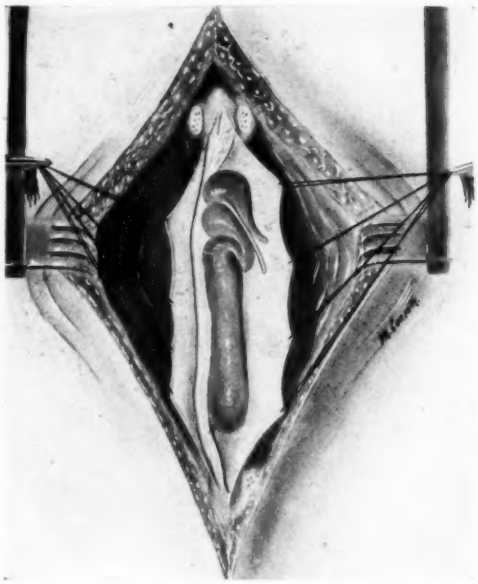


Fig. 7. Type of vascular lesion in which one large vein compresses the cord. This was dissected out without much difficulty.

Of all the gratifying experiences in surgery, I know of none greater than to make the paralyzed walk, except perhaps to make the almost blind see. This is what we can do by removing spinal tumors in time. The vast majority of spinal tumors are benign, encapsulated growths growing from the dura. They are either endotheliomata or fibromata. With care they may be removed so that no increase of the spinal symptoms occurs and, though it is rare to have all traces of spinal symptoms disappear, they clear up to such an extent that the patients are useful citizens with no appreciable discomfort or disability. There may be some increased reflexes or spasticity left or some sensory disturbance.

The localization of a tumor frequently offers considerable difficulty. It may be possible to determine the level from the sensory disturbances, the paralyses, and disturbed reflexes. If, by study of these, one fails to establish the level, the Queckenstedt test, and finally an injection of lipiodol into the cisterna magna, may be of great assistance. I have never had any help from spinal

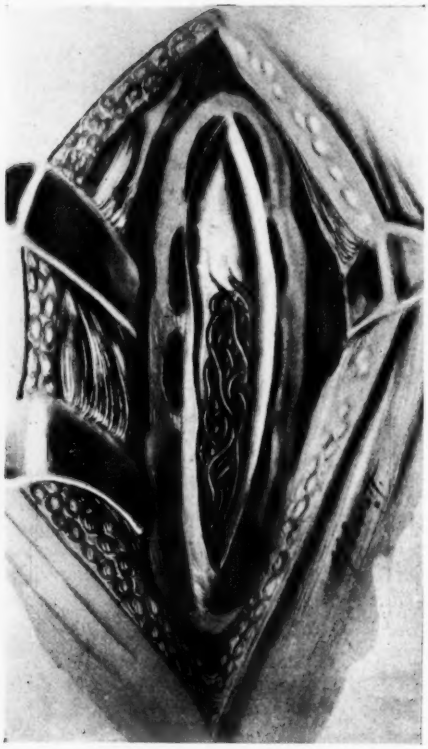


Fig. 8. Type of vascular lesion which cannot be removed by the ordinary surgical methods but which might be dealt with by electrosurgical methods.

air injection in these cases. Lipiodol I use only when other methods fail, for there is no doubt, as Ayer has shown, that it is irritating, though I have as yet seen no untoward symptoms from it. Occasionally all these signs fail, as occurred in an unusual case of tumor of the terminal portion of the cord, possibly of the filum terminale. In this case the first and only complaint of the patient was inability to empty his bladder. He went to a genito-urinary surgeon[1] who concluded that the bladder retention was due to a cord lesion. At operation we found the condition shown in Figures 5 and 6. This lesion did not obstruct the canal, consequently both Queckenstedt and lipiodol tests were negative.

[1] This patient fortunately fell into the hands of Dr. D. K. Rose who has invented an instrument called a cystometer by which he is able to distinguish the type of nervous lesion causing various types of bladder disturbance.

The treatment of intramedullary tumors is far less satisfactory, since most of them are some form of glioma. Just what group these gliomata belong to remains to be seen; the new cytological methods of Hortega, which Dr. Wilder Penfield and Dr. Bailey have done so much to improve and apply to tumors, will enable us to pick out those that are favorable from an operative standpoint as well as those that respond to X-ray treatment.

Whereas the operation of laminectomy is far simpler than a cranial operation, it should be emphasized that the spinal cord tolerates manipulation far less than does the brain. Slight trauma of the cord during an operation may cause permanent disability. Some years ago I was obliged to reoperate upon a patient who had become totally paralyzed immediately after an exploratory operation elsewhere for a supposed tumor. At the site of the old operation, I found a traumatized contused cord and from what information I could gather I believe that the slipping from a rongeur caused this injury. The greatest gentleness must be used in the handling of the cord but of this and a few other technical matters I shall say a few words later on.

A certain group of cases presents the picture of a focal spinal lesion. Such patients are difficult to handle since they are entitled to an exploration, yet at operation nothing can be done. Two years ago I reported a series of 33 such cases. Every diagnostic method should be used to cut this number down as low as possible, but where a localized lesion is demonstrated by lipiodol or the Queckenstedt test, an exploratory operation must be done to determine the nature of the lesion. In some of these patients the lesions are due to old inflammatory processes which have left adhesions which constrict the cord, but in other cases no gross pathological lesion is found and the result of exploration is entirely negative.

Among the group of spinal tumors, blood vessel tumors may be encountered which present atypical symptoms and extremely difficult operative problems (Figs. 7 and 8). They deserve special mention because their symptoms are unlike those of a solid tumor and resemble those of the series just referred

to—the arachnoiditis cases. Some of them are composed of a mass of thin walled vessels that cannot be removed by any of our present methods though it may be possible in future to deal with them by electrosurgical methods.[1]

An entirely different group of patients that the neurosurgeon can do something for are those with intractable pain, sometimes due to a malignant metastasis, sometimes to tabes, and sometimes to no detectable cause. For these cases chordotomy, the so-called Spiller-Frazier operation, may be a great comfort. It consists in the cutting on each side of the spinal cord of the anterolateral column which carries the pain fibers. The operation should be done high in the dorsal cord so as to catch the pain fibers well above the site of pain. When this is properly done, the patient loses all sensation to pain below a certain level but retains normal touch and temperature sense. In a patient with a malignant metastasis to the spine, the relief may be complete and this obviates the use of opiates, but it is only fair to say that chordotomy does not always give complete relief. Whether this is due to a failure to get all the pain fibers or due to some other cause, I do not know, but not all the cases have yielded uniform results. To what extent the operation is applicable to patients with tabetic pains is also uncertain for some have complete relief and others seem to have little or none. The operation has to be carried out with great care, for under the anterolateral column lies the crossed pyramidal tract. If the incision is too deep a motor paralysis may be produced while if incision is not deep enough the pain may continue. The tract that is cut is about 2.5 millimeters long and 2 millimeters deep (Fig. 9).

The last group of cases which the general surgeon is frequently called upon to take care of consists of patients with congenital defects—various types of spina bifida. If unruptured and there is evidence of some nerve fibers passing into the lower extremities or some rectal control, the patient should be operated upon at an early age. A considerable percentage develop hydrocephalus, it is true, but

[1] Since reading this paper, I have successfully removed an angioma in the region of the fourth ventricle with the aid of the Bovi scalpel. I feel quite certain that I could not have dealt with it in any other way.

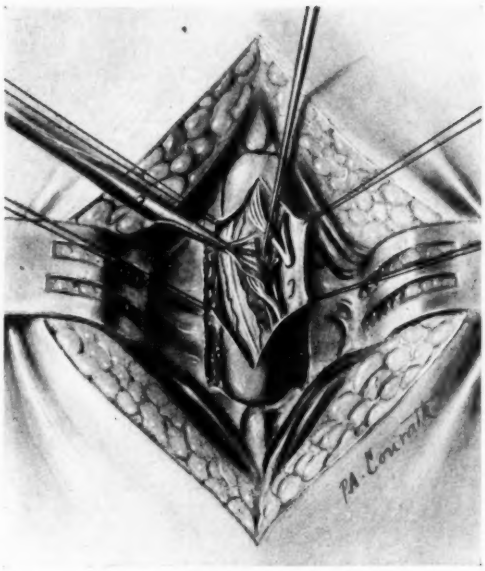


Fig. 9. This shows the way in which the spinal cord may be rotated by grasping the ligamentum denticulatum; it also shows the way in which the anterolateral column is cut in a chordotomy.

I know of no way of determining beforehand which patients will do this. Because of the possibility of hydrocephalus developing, this is a discouraging chapter so far as end-results are concerned, although the operative procedure is usually simple. Our aim is to close the dura after the hernial contents have been reduced and to close the defect with a fascial flap taken from one or both sides as may be necessary. I have never found it necessary to use a bone graft as has been suggested, in fact, I believe giving a little room for expansion is the wiser thing to do.

There are those who advocate waiting until a child is at least a year old before an operation is done but this does not seem wise, for though it is true many will die in the first year if left alone, and only the most favorable cases survive, some of these could be saved and, for the sake of those few, operation should be resorted to early.

TECHNIQUE OF LAMINECTOMY

As regards the operative technique for laminectomy, a few words should suffice. I

always make a median line incision and carry it down to the spinous processes; then with great care the periosteum is stripped from the spinous processes so as not to injure the muscles. With this technique extremely little bleeding is encountered. The entire spinous process is removed down to the articulating processes on each side. There is some difference of opinion about this. Taylor advocates unilateral laminectomy in order to keep the spinal column stronger. Mixter does not remove the spinous processes.

Taylor has recently described a number of cases in which cervical laminectomy was done and the patient suffered a forward dislocation; this should certainly be kept in mind as a possible complication. Whether this has occurred in my series of over 150 laminectomies I do not know, for Taylor points out it may occur without symptoms and only a lateral X-ray picture will reveal it. I know of no patient who has had symptoms which might be ascribed to such a complication and am inclined to think that a very careful layer closure may prevent its occurrence.

After the canal is opened, great care must be exercised not to injure the cord by pressure or sponging or getting blood into the subdural or subarachnoid space. No gauze sponges are ever allowed at this stage, only the finest quality of cotton, and with the judicious use of suction the cord is gently handled. If it becomes necessary to work in front of the cord or on one side, the cord should be handled only by means of the ligamentum denticulatum; to retract the cord with a retractor is never permissible,—that is quite enough to cause a paralysis below that point. In order to do a chordotomy the cord has to be rotated over 90 degrees. This can be done by taking hold of the ligamentum denticulatum on each side. No clamps are ever to be applied to the cord. A bleeding point as a rule can be controlled with hot cotton and the application of a bit of muscle. Occasionally a silver clip may be necessary to control a vessel. This is much less harmful than the putting on of a clamp and then the tying of the vessel. If an endothelioma is encountered, the dural portion from which it grows must always be excised as otherwise there is likely to be a recurrence. If a large piece of dura is removed, a fascial transplant may be necessary to close the defect and prevent any cerebrospinal leak, but with a careful layer closure of muscles, deep and superficial fascia, a dural leak need never occur. A heavy gauze pad and binder is all these patients need for a dressing, the old idea of a plaster dressing or plaster bed is totally unnecessary.

A CLINICAL AND PATHOLOGICAL STUDY OF TWO TERATOMATOUS CYSTS OF THE SPINAL CORD, CONTAINING MUCUS AND CILIATED CELLS

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THE two cases which we are about to report present features which, both from clinical and pathological standpoints, are interesting and puzzling. We propose therefore to record both aspects of the cases in some detail. It is perhaps worthy of note at the outset that in each patient symptoms appeared first at the age of 2 years, but the second patient did not come to operation until 25 years after the onset of her trouble.

Case 1.[1] *Children's Hosp. No. 105253. A cyst arising from the dorsolateral surface of the upper lumbar cord was associated with occult spina bifida, and suddenly produced symptoms of cord compression in a boy two years of age. The cyst contained ciliated cells and mucus. Dorsolumbar laminectomy; extirpation of cyst; recovery.*

D. S., an Irish boy, aged 2 years and 2 months, was first admitted to the Orthopædic Clinic of the Children's Hospital, Boston, May 21, 1927, discharged a month later, and again admitted for further observation on July 22, 1927. His family history contained nothing relevant to his condition. In his own past history, the only important fact was that he had always walked with a slight dragging limp of the right leg. He was admitted for the first time because he had recently been fretful and for several weeks had stopped eating and lost weight.

The child cried almost constantly, in apparent pain. His back was rigid, with intense spasm of the lower spinal muscles, and he stood up only with the greatest reluctance. When lying on his back he held his legs partially fixed; and his pain seemed to be greater upon passive motion of the limbs, especially at the left hip. The clinical suggestion of tuberculosis of the bone was not borne out on repeated X-ray examination and repeated tuberculin tests. The roentgenogram revealed, however, a spina bifida occulta, with incomplete fusion of the lower thoracic, lumbar, and sacral vertebræ, most marked in the first, second, and third lumbar arches. Neurological study revealed hyperactive deep reflexes in both lower limbs, but especially on the right; there was also a poorly sustained ankle clonus and a positive Babinski on the right. In the course of a few weeks he seemed to lose whatever sphincter control he had previously possessed, and then developed an apparent zone of hyperæsthesia at the level of the umbilicus.

Lumbar punctures. On June 13 a lumbar puncture yielded fluid that was contaminated with a sma l amount of fresh blood (presumably a "bloody-tap"). The pressure, under anæsthesia, was normal, and the response to jugular compression showed that there was no block. Six weeks later, however, on July 29, a pale yellow fluid was obtained at a second lumbar puncture, containing two cells and a 4-plus "Pandy." The fluid failed to clot on standing. On this occasion the cerebrospinal fluid pressure varied between 0 and 10 millimeters of fluid, and there seemed to be little or no increase in the pressure on compression of the jugular veins. In 6 weeks, therefore, a condition of at least partial block had developed, and a xanthochromic, non-clotting fluid had appeared below the level of the suspected obstruction. (It is possible, but not likely, that the color was due to blood introduced at the previous puncture.)

Three days later a combined cistern and lumbar puncture was done. The cerebrospinal fluid from the cisterna magna was normal and under normal pressure. From the lumbar region, however, at a level one interspace above that of the earlier punctures, an entirely novel fluid was obtained. This fluid was so viscous that it had to be aspirated with a syringe. It was in the main quite clear and colorless, with a few cloudy streaks running through it. In appearance and in physical characteristics it was exactly like the white of a raw egg. In it were found 2700 cells which were incorrectly reported (from a counting-chamber analysis) as lymphocytes. No pressure measurements could be made upon this viscous fluid. On August 3, an injection of lipoidol was made into the cisterna magna, under ether anæsthesia. Although the main mass remained above the level of the ninth dorsal vertebra, scattered droplets of lipoidol descended to the caudal tip of the dural sac. In the head-down position the oil droplets which had previously slipped down past the dorsal level collected at a point below the partial obstruction, without repassing it.

On August 5, therefore, two diagnostic punctures were made, one at the level of the tenth dorsal interspace, and the second at the fourth lumbar. The upper puncture again secured a sample of the gelatinous mucoid fluid. The cells of this fluid were examined by the supravital technique of Sabin (25), and were found to be predominantly large, round, granular, mononuclear, *ciliated* cells (Fig. 1), with a

[1] We wish to express our gratitude to Doctors Robert B. Osgood, Bronson Grothers, and Gilbert Horrax for permission to report this case.

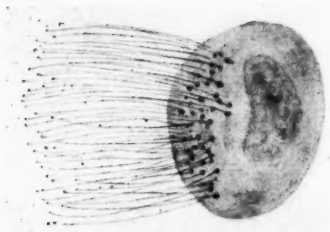


Fig. 1. Free-hand drawing of ciliated cell from the supravital preparation of mucoid fluid from the cysts. Each cilium could be seen to arise from a large refractile granule, and to terminate at the free end in a smaller granule. These desquamated cells were granular and evidently degenerating. No ciliary movement was seen even in those taken from Case 1 by lumbar puncture.

few polymorphonuclear neutrophilic leucocytes, a few lymphocytes, and a few red blood cells. The puncture at the lower interspace released a clear fluid with a normal cell count and fair, though slightly sluggish, responses to jugular compression. It seemed evident, therefore, that the withdrawal of the viscous fluid at the upper level had lessened the obstruction in the subarachnoid space, thereby diminishing the block and eliminating the previously observed xanthochromia. Just before the operation, on August 11, the punctures of August 5 were repeated with similar findings. Chemical examination of the viscous fluid showed it to contain large amounts of mucin and a total protein of 657 milligrams per 100 cubic centimeters; while the cerebrospinal fluid from below the lesion had lost its xanthochromic tint, gave a negative Wassermann

TABLE I.—SUMMARY OF LUMBAR PUNCTURE FINDINGS IN CASE 1

Date	Level	Fluid	Pressure	Jugular Compression
June 13	L4-5	Slightly bloody.....	Normal	Normal
July 29	L4-5	Pale yellow. No clot. Increased protein (Pandy 4-plus).....	0-10 mm.	Noresponse
August 1	Combined cistern-lumbar	Normal.....	Normal	Normal
	13-4	Viscous fluid aspirated into syringe, clear and colorless.....	Too viscous for pressure measurement	
		Consistency like white of a raw egg. 2700 cells, uncertain nature.....		
August 3	Lipoidol	into cistern. Partial obstruction at level of ninth dorsal vertebra..		
August 5	L4-5	Clear, colorless, normal cell count.....	Normal	Slightly sluggish responses
	D-10-11	"Egg-white" fluid. Cells seen to be ciliated (Fig. 1).....		
August 11	L4-5	(On operating table, just before operation.) Normal but for slightly increased protein: 51 mgm./100 ccm.....		
	D10-11	As above. Positive mucin tests. Total protein 657 mgm./100 ccm. ..		

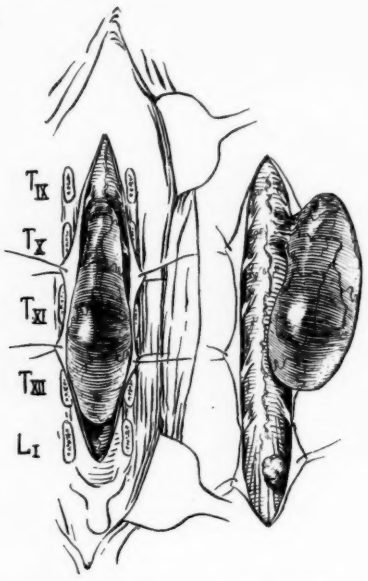


Fig. 2. Tumor of Case 1. A, As seen at operation immediately after incising the dura. B, Side view reconstructed; note pedicle of tumor and character of attachment to the cord. (From Dr. Horrax's sketch made immediately after operation.)

test, a negative gold sol curve, and contained 57 milligrams sugar, 717 milligrams sodium chloride and 51 milligrams of total protein per 100 cubic centimeters. In short, the fluid below the level of the lesion was now normal but for a very slight increase in the total proteins. A summary of lumbar puncture findings is given in Table I.

The facts brought out by this series of studies may be summarized as follows: (1) A rapid development of spinal block and weak xanthochromia in the lumbar fluid, in the interval between punctures 1 and 2. (2) Partial removal of the block and disappearance of the xanthochromia very rapidly after a higher puncture which obtained the thick, egg-white fluid (i.e., partial evacuation of the cyst). (3) Demonstration of a level of partial obstruction at the ninth dorsal vertebra by lipiodol. (4) Repeated removal of an "egg-white" fluid from the upper lumbar region which contained ciliated cells and mucin.

Operation. Operation was done August 11 by Drs. Gilbert Horrax and Tracy Jackson Putnam. Laminectomy disclosed within the subarachnoid space a silver-gray, shimmering cyst, nearly 6 centimeters long and 1.5 centimeters in diameter, which was bathed in cerebrospinal fluid and overlay the cord from the level of the ninth dorsal to the first lumbar vertebra. A drawing made from Dr. Horrax's excellent operative sketch is given in Figure 2. On aspirating the contents of this cyst into a

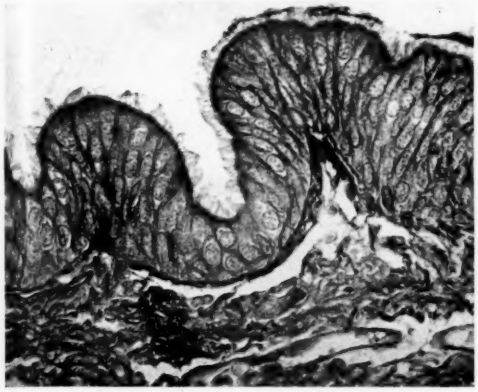


Fig. 3. Ciliated epithelium from the lining of the cyst in Case 1. x 375. Stained in hæmatoxylin-eosin after Zenker fixation and mordanting in Regaud's solution. The cell borders, basement membrane, and at some points the granules on the cilia are clearly brought out.

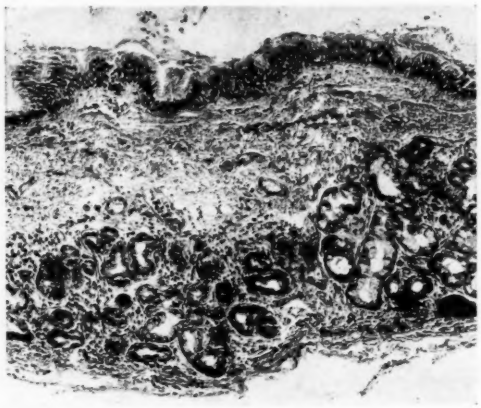


Fig. 4. Thickened area of the cyst wall from Case 1. x 65. Zenker, hæmatoxylin-eosin. The dilated vascular channels and the mucous and serous glands are seen in their relation to the epithelium.

syringe, it was found to contain both the viscous mucoid fluid and the ciliated cells which had already been obtained at lumbar puncture. Over the delicate surface of the cyst were fine blood vessels which gathered together at the level of the ninth dorsal spine into a fine, and, apparently, solid stalk. Through this stalk the cyst seemed to grow out of the right dorsolateral surface of the spinal cord, approximately out of the tip of the dorsal horn of the grey matter.[1] This vascular stalk was clipped with two silver clips and severed in between them. The sac was promptly removed and fixed in Zenker's fluid. No central channel could be made out through the stump of the stalk. The cord, beneath where the cyst had pressed against it, was slightly flattened. At the lower end of the cord, just above the cauda equina, there was imbedded in the right side a hard nodule, about the size of a pea. This was left untouched.

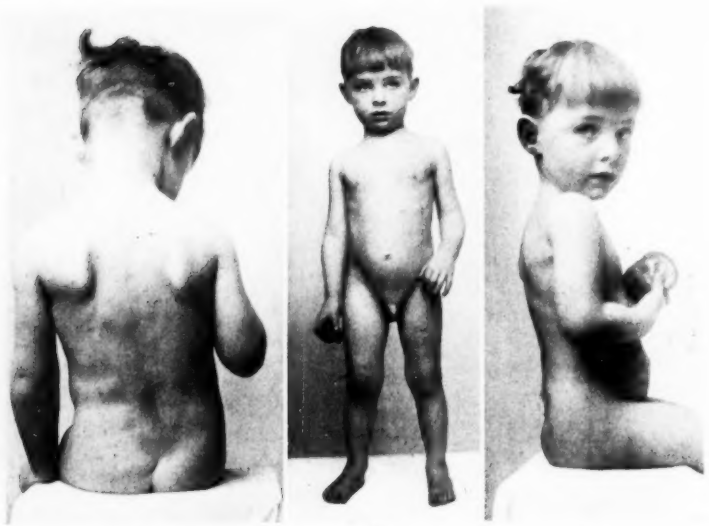
Histological appearance. The sections were stained in hæmatoxylineosin, carmalum, phosphotungstic-acid-hæmatoxylin (Mallory); and after secondary mordanting in Regaud's solution, unsuccessful attempts to secure mitochondria stains were made with acid-fuchsin-methyl-green (Cowdry).

The greater part of the cyst wall was of almost paper-thinness, and at only one point was there palpable thickening. Sectioning of the cyst showed that the thin, membranous wall consisted of a capsule of connective tissue and blood vessels which was lined by a layer of epithelium. The epithelial layer was composed of cells which varied in structure from low cuboidal to high columnar, and in places patches of uncovered connective tissue could be seen denuded of their epithelial layer. The area of thickening in the wall, however, presented a picture of surprising complexity. Here the epithelium was made up of tall, columnar cells in pseudo-stratified layers. The cells were ciliated at their free border, and lengthened out to form long tails which pointed centrifugally toward a fairly well-defined basement membrane (Fig. 3). Below this were found abundant blood vessels, connective tissue, and actively secreting mucous and serous glands (Fig. 4). There were in addition some interstitial hæmorrhages (which might conceivably have been induced at the operation); and polymorphonuclear leucocytes were scattered sparingly throughout the tissue, without any point of great concentration, suggesting a subacute inflammatory process. Smooth muscle was also present. A few large myelinated nerve fibers were seen but there were no nerve cells or glial elements.

Postoperative course.—The postoperative course of the child in the hospital was uneventful. Within a few days he had ceased his previously incessant crying, and was a little less alarmed when approached. The hyperæsthetic zone over the abdomen and thighs was gone; control of the sphincters returned, and the reflex changes became much less clear-cut. He was sent to a convalescent nursing home on August 26.

The child was last examined on February 11, 1928. At this time he ran around the examining room without apparent disability. No knee-jerk could be obtained on the left side; and on the right only a feeble and inconstant response. The ankle-jerks, on the other hand, were active; and again the right side was more active than the left. The cremasteric reflexes were present on both sides, but sluggish on the right. The abdominal reflexes were absent in

[1] It is possible, of course, that the inner relations of the cord were distorted, and that this dorsolateral point of attachment may have been in the line of mid-dorsal closure of the neural tube, displaced to the right by the developmental anomaly.



A. B. C.

Fig. 5. Photographs of our first patient 7 months after operation showing: A, Region of laminectomy incision at lower end of which is evidence of a slight spina bifida. B and C, Normal posture of patient in two positions.

the lower quadrants, but were feebly responsive in the left upper quadrant. The Babinski response were indeterminate; on the right the great toe turned up, the foot turned inward, and the reaction spread slightly to the other toes, usually with slight flexion; the response on the left side was of the same nature but less marked. Measurements showed the left leg to be ⅛ to ¼ of an inch smaller in circumference than the right. The abdominal muscles were strong, the child sitting upright from the prone position without difficulty. No sensory difficulties could be made out.

It could not be determined whether the reflex disorders observed were residuals from the pressure which the cyst had exerted, or whether they were due to the nodule which had been seen at observation lying in the right side of the cord, just above the cauda equina.

Case 2.[1] *P.B.B.H. Surg. No. 29612. Recurrent attacks of hemi- and quadriplegia at 2½, 9, 12 and (the present) at 27 years, associated with pain in back of neck and Brown-Séquard dissociation of sensation over body. Emergency cervical laminectomy with removal of left dorsolateral cord cyst at third cervical containing mucus and ciliated cells. Rapid recovery of power and sensation.*

K. J., an unmarried American stenographer of 27 years, was admitted to the neurological service of the Peter Bent Brigham Hospital on September 8, 1927, as a spinal cord tumor suspect, on the recommendation of Dr. J. E. White of Malone, New York, and Dr. E. N. Boudreau of Syracuse, New York, because of paresis and numbness of her extremities. There was no history of any similar condition occurring in the patient's family.

The patient had been told by her mother that at the age of about 2½ years she had had a "convulsion" after which she lost completely the use of her arm and leg on the left side. The condition developed suddenly, lasted about 5 weeks and disappeared rapidly, apparently leaving no residual defects.

At the age of 8 she had a period of slight weakness of her left side lasting only 2 weeks, but a year later she had a more severe seizure during which she went to the Royal Victoria Hospital, Montreal (August 31, 1909) for observation. Through the courtesy of this institution, we have seen the excellent history made at that time. The patient's father stated that 7 weeks before admission she had been taken with severe pain in the left side of her neck, especially over the upper three cervical vertebræ, and a few days later the left arm and leg became almost powerless. The father had observed a week after the onset that the child's left eye-lid drooped, that the left pupil had become smaller than the right, and that there appeared to be a slight internal squint (left). She also had had marked orthopnœa. Examination on entry showed that the right pupil was still larger than the left and that there was a left "ptosis" (enophthalmos). "Occasionally," the history reads, "deep inspiration causes a paroxysm of pain in left shoulder . . . whenever patient is put in level

[1] We wish to express our gratitude to Dr. Harvey Cushing for permitting us to report this case.

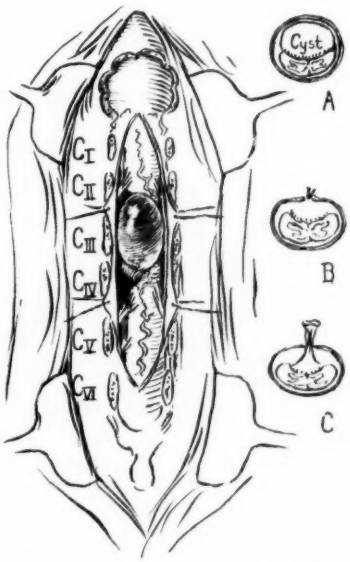


Fig 6. Operative field in Case 2, as redrawn from Dr. Cushing's immediate postoperative sketch, giving appearance and approximate position of the lesion. Also, A, a transverse sketch of the cyst *in situ* showing the compression of the spinal cord beneath it. B, The closure of dura over remaining adherent portion of cyst. C, What, according to operator, would presumably have been a more effective way of dealing with lesion in view of its possible future redevelopment.

Fig. 7. Case 2. X-ray pictures of cervical region after operation. Note the slight widening of upper cervical canal. In this film the position of the silver clip shows the exact level of attachment of the cyst to the spinal cord. The approximate size of the cyst is indicated by dots. The spinous processes and laminæ are missing from the second to the sixth inclusive.

position in bed she immediately becomes dyspnœic and cries out that she is suffocating." There was marked pain when an attempt was made to bend her head backward. It was observed also that *her left arm and hand were smaller than her right* (glove measurement: 17 centimeters right, 16 centimeters left; also 1 centimeter difference in diameter and in length of arms; no difference in legs), and there appeared to be wasting of the flexor muscles of the left arm and of the left hypothenar eminence. The deep reflexes on the left were markedly increased and there was persistent patellar and ankle clonus. While she was under observation her condition rapidly improved and she was discharged on September 9, 1909, with a tentative diagnosis of hysteria. Improvement continued, and 3 to 4 months from the onset of the attack she was again "perfectly well."

At the age of 12 the same thing once more occurred. Again the symptoms began with stiffness of the neck, followed closely by pain in the left side of the neck and in the left shoulder, and finally by a gradual development of paralysis. The weakness appeared first on the left side, but in this attack the paresis also spread to the right, until in the end paralysis and "numbness" existed all over her trunk and four extremities. During this attack, the patient again suffered agonizing pain in her neck and shoulders. The paralysis was not absolute—enough voluntary power remaining to enable the patient to "work herself around" in bed. There were no sphincter difficulties. Recovery again set in with great rapidity; and this time it was initiated by a sudden sensation that "something had happened" in the back of the neck. Within a few days after this sensation occurred, practically all of the symptoms had disappeared. At no time had there been any headache, fever, diplopia, or other cranial nerve disturbance, and no convulsions or other manifestations of forebrain pathology. After this attack the patient's left hand remained permanently weak and never developed as completely as the right. However, during the 15 years which intervened between this attack and her present seizure, its usefulness in her occupation of stenography was but little impaired. Almost every summer since this attack, the patient suffered from *short periods of stiffness of her neck and some numbness and pain*, and occasionally some muscular weakness in her left arm. These abortive attacks always passed off, however, with rest in bed.

Present attack. On August 1, 1927, the present attack developed. The sequence in which the symptoms appeared was almost exactly that of the

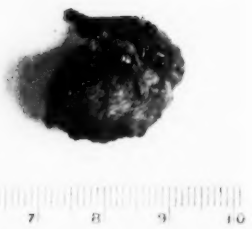


Fig. 8. The cyst from Case 2, before sectioning. Approximately natural size, though, owing to the use of the electric loop in excising it, the distal end of the cyst is considerably shrunken.

Fig. 9. Section of the cyst wall from Case 2. x 38. Formalin, Zenker mordant, H. and E. The epithelial layer, bands of smooth muscle, dilated blood vessels, lymphoid areas, and scattered glands are all visible.

earlier attacks: stiff neck, pain in the shoulder, weakness first on the left side, followed by spread to the right; numbness first on the right side, followed by spread to the left. In this condition the patient was brought to the hospital.

Neurological status prior to operation. (This is a summary of repeated examinations made during the 24 hours that the patient was in the hospital before an emergency operation was performed owing to the onset of increasingly labored respirations.)

Spontaneous pain and posture: From preference the patient held her head in forward flexion. Any motion from this position, especially any turning of the head, caused excruciating pain which radiated up the back of the neck to the occiput and down the shoulders. Sneezing, coughing, or gentle pressure on the jugular veins precipitated similar attacks of agonizing pain. The lower cervical vertebræ were acutely tender.

Respiration: The breathing was exclusively diaphragmatic, with no participation of the intercostal muscles. During the 24 hours of observation the breathing became gasping and labored.

Cranial nerves: These were essentially uninvolved in the process. There was moderate passive congestion of the fundi, without elevation of the discs or obscuration of their margins. The fact that the left eyelid drooped and that the left pupil was smaller than the right suggested pressure on the left cervical cord. The left side of the face was more flushed than the right.

Motor power: There was almost complete loss of voluntary motion in all four extremities, the left arm and leg preserving a little more free motion than the right; but the exact condition varied from hour to hour. Despite the fact that the left arm was slightly less involved this time, the earlier attacks had left this arm and hand markedly smaller than the right, glove measurements showing the right 3 centimeters larger than the left (at the age of 9 the difference was only 1 centimeter, v.s.). This difference seemed to be due more to uniform failure of development of all of the muscles and bones of the left upper extremity than to developmental failure of any special muscle group. The left arm and hand lay in partial flexor spasm much of the time. It could be weakly flexed at the elbow and some voluntary motion of the fingers was possible. The right was flaccid and motionless. The patient could flex both legs weakly at the hips and knees, the left more than the right, and while free motion of the left toes was possible, none was present on the right side. At the time of examination, therefore, although the paralysis had begun on the left side, it had become more profound on the right.

Deep reflexes and clonus: All of the deep reflexes were markedly hyperactive. Clonic phenomena were elicited in both arms and in the fingers of both hands, but especially on the left. In both lower extremities, gluteal, patellar, and ankle clonus could be elicited, but these were more sustained on the left than on the right side. These clonic responses were readily inhibited by pinching the skin of the limb in which they were occurring. The right side was more flaccid, the left more spastic.

Superficial and associated reflexes: Abdominal reflexes were absent. Gentle stimulation of the sole of the foot produced intensely active, positive Babinski responses, and the wide spread of the sensitive zone was evidenced by the presence of positive Chaddock, Oppenheim, and Gordon phenomena. A variety of uncontrollable, associated reflex phenomena could be produced by slight stimulation of the skin (e.g., pinching), especially on the left side, but also on the right. Of such a nature was the inhibition of clonus by gentle pinching of the active limb. More vigorous pinching of the lower extremity caused marked ipsilateral flexor spasm (defensive reflex) with *contralateral extension* (Phillipson's reflex); and similar stimulation of the upper limb caused ipsilateral

Fig. 10. Another area of the cyst wall of Case 2. x 75. Formalin, Zenker mordant, hæmatoxylin-eosin. Here the epithelium is seen to form deep branching invaginations through the layer of smooth muscle and lymphoid infiltration. Still deeper are seen mucous and serous glands, fat cells, etc.

extensor spasm of the arm with flexion of the hand, and sometimes a spread of the response to include flexion of the ipsilateral leg with contralateral extension. It is perhaps significant that there was spreading of these involuntary associated reflexes from the upper extremities to the lower, but *not* vice versa. There were also frequent attacks of spontaneous uncontrollable movements from time to time, occurring possibly on the basis of accidental skin stimulation. Sudden violent extension of the arms with flexion of the fingers at the proximal joints was especially frequent.

Objective sensory disturbances: All disturbances of sensation were found below a line which ran from the top of the acromion on the shoulders to a point 2 inches below the episternal notch on the sternum, corresponding roughly to the lower limits of the sensory distribution of the third and fourth cervicals. Below this level she presented a more or less typical Brown-Séquard sensory dissociation. Heat, cold, and pain were grossly impaired all over the right side below this level, but were less impaired on the left; whereas position sense was only partly impaired on the right side but was more grossly affected on the left.

Minor symptoms: The patient had suffered from chronic constipation for some time, and for 2 days

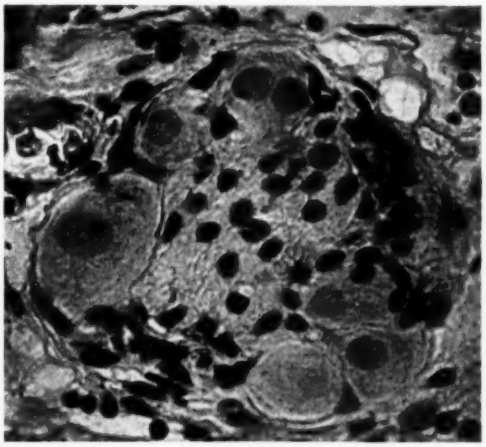


Fig. 11. A clump of cells which resemble ganglion cells from deep in the cyst wall of Case 2. x 650. Formalin, Zenker mordant, hæmatoxylin-eosin.

had had urinary retention, so that catheterization was necessary on admission. The *skin* showed excessive dermatography and even gentle pinching caused a rapid development of subcutaneous ecchymoses. The patient was extremely obese. The left side of the body was warmer than the right.

Summary. A young woman, 27 years of age had had recurrent attacks of paresis of extremities with subjective sense of "numbness" in trunk and limbs. On admission to the hospital she had almost complete paralysis of all four extremities and of the intercostal muscles, with extreme hyperactivity of reflexes, the greater reflex hyperexcitability being on the left side; the greater loss of voluntary motion on the right. She suffered from constipation, urinary retention, and vasomotor skin disturbances (i.e., dermographism, ecchymoses, and uneven distribution of skin temperature). Root pains extended up the back of the neck and down the shoulders, and were intensified by coughing, sneezing, or compression of the jugular veins. Below the level of sensory distribution of the fourth cervical nerve there was marked diminution of all cutaneous sensation,—with a tendency to a Brown-Séquard dissociation—i.e., with pain, temperature, and light touch more involved on the right and paralysis and position sense more involved on the left.

Impression. Compression of the cord at the level of fourth cervical, most marked on the left side. With the recent experience of Case 1 in mind, the suggestion was ventured that this might prove to be a similar congenital cyst, either with or without association with spina bifida.

Pre-operative course. On the afternoon of September 9, the day following admission, the patient was taken to the X-ray room to have films made of her

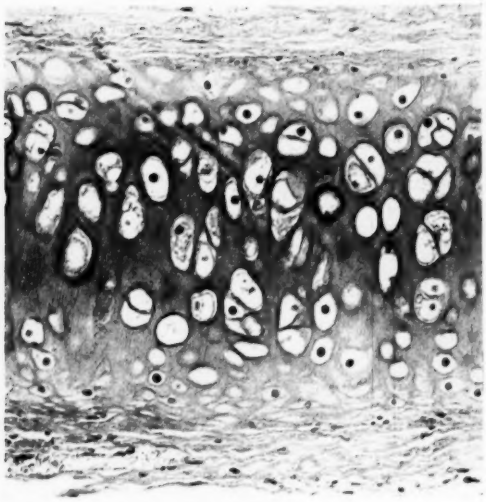


Fig. 12. Cartilage from the wall of the cyst in Case 2. x 220.

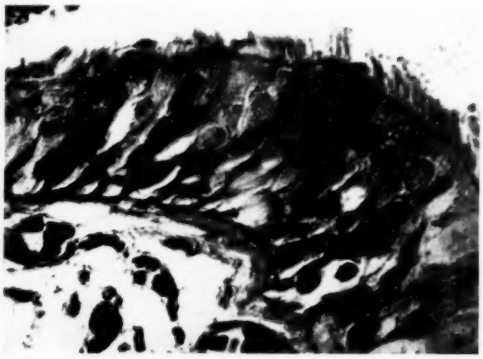


Fig. 13. Ciliated epithelium from a portion of the invagination shown in Figure 10. x 595. The basement membrane, the tailed form of the cells themselves, the dense free border of the cells, and the granular tips of the cilia are all seen. Formalin, Regaud mordant, hæmatoxylin eosin.

cranium and spine. Her paralytic symptoms had been rapidly increasing, and while recumbent on the table she began having greatly embarrassed respiration evidently from involvement of her phrenic nerves. Dr. Cushing, who had not as yet examined the patient, was summoned, and, realizing the urgent nature of the condition, he felt that immediate intervention was imperative. It was his impression that though the symptoms pointed to an involvement threatening the fourth cervical level, the lesion might well enough be as high as the foramen magnum. Accordingly plans were made for an emergency laminectomy under local anæsthesia of the entire cervical spine. It was not until the operation was in progress that the X-ray plates were developed and reported upon, showing a definite widening of the canal in the mid-cervical levels (Fig. 7).

Operation was done September 9, 1927 by Dr. Cushing. The operation was performed with unusual difficulty, partly on account of the patient's extreme obesity, partly because of her respiratory difficulties which in face-down position tended to increase, but more particularly because she manifested throughout the operation the same hæmorrhagic tendency which she had shown by her proneness to develop subcutaneous ecchymoses during her examinations. Every surface oozed blood almost constantly, so that even after the removal of the cyst a long time was spent merely in checking this persistent bleeding. A laminectomy of the middle six cervical vertebræ with partial removal of the occipital bone around the foramen magnum was finally made, great care being exercised lest the trauma of the procedure increase the existing pressure symptoms. Throughout this tedious and hazardous procedure the patient was most co-operative. As events proved, the multiple laminectomy was unnecessarily extensive, though owing to the patient's short and thick neck there was none too much room for the manipulation of the lesion. When the dura was opened, a tense, oval, greyish tumor, which underlay the partly adherent arachnoid membrane (Fig. 6) and was at first mistaken for a meningioma, was exposed. It lay about at the center of the operated field, namely, at about the third-fourth cervical segmental level. An attempt to free this tumor caused it to rupture, allowing the escape of a sticky, viscous fluid which was mainly clear, with a few grey streaks through it. The fluid was aspirated and examined, as in the other case, by the supravital method of Sabin (25). It proved to contain mucus and ciliated cells, which were identical in structure with those of Case 1 (Fig. 1). The base of the cyst was so densely adherent to the dorsal surface of the cord over a small area that it could not safely be removed in its entirety. The freed portion of the cyst wall was burned with the electrosurgical knife as close to its attachment as was possible (Fig. 8). The entire operation, which lasted nearly 7 hours, was performed chiefly under novocain. Ether had to be given for a brief interval (about 20 minutes), while the cyst itself was being dislodged, for this manipulation caused intense pain which, curiously enough, was usually referred to her stomach. Toward the end of the operation, as a precautionary measure, a transfusion of 250 cubic centimeters of blood was given. Throughout the operation the patient talked naturally and cheerfully, except for the short period of pain just before the administration of ether. Dr. Cushing's operative sketch (Fig. 6) showing the position of the cyst and what he

thought ought to have been done with it (Fig. 6,C) to lessen the likelihood of recurrence, is given herewith. The cyst was fixed in formalin.

Histological examination. This cyst was relatively heavy-walled (Fig. 8), varying between 1 millimeter and 2 millimeters in thickness. Viewed from the inside, it was seen to be split by ridges and grooves into an irregular cavity. At one point, however, the wall reached a thickness of nearly 3 millimeters. Sections were cut through several regions and stained as in Case 1. As in the other cyst, the thinner areas were relatively simple: toward the lumen was an epithelial layer consisting of low cuboidal to high columnar cells. Outside this lay not only connective tissue, but also long flat bands of smooth muscle (Fig. 9). On nearing the thickened zone, groups of glands were seen (Fig. 10) and complex branching invaginations of the epithelium (Fig. 10). Finally, in the widest area were great masses of lymphoid tissue (Fig. 9), abundant smooth muscle bands (Figs. 9 and 10), many blood vessels, some cartilage (Fig. 12), and—as in the other—quite extensive interstitial hæmorrhages with some evidence of acute inflammation. Many small bundles of myelinated nerve fibers were found and in one area large round cells which resemble nerve cells (Fig. 7), but since special stains for tigroid substance and neurofibrillæ were not made because of the fixation, their positive identification is open to doubt. Next to the lumen of the cyst was an epithelial layer of pseudo-stratified columnar cells with cilia and pointed tails leading centrifugally toward a basement membrane (Fig. 13). In the connective tissue, near the meningeal surface, were occasional, solidly calcified blood vessels, forming typical psammoma bodies.

Postoperative course. An immediate and dramatic return of function began, even before the patient was removed from the operating table. Voluntary flexion and extension could be performed weakly at both wrists; there was free movement of the fingers, flexion and extension of the ankles, flexion of the knees, and a beginning return to thoracic respiration.

During the succeeding 24 hours the improvement went on, hour by hour. Full participation of the intercostal muscles in the movements of respiration recurred. Micturition was possible. Voluntary movements of the extremities became increasingly free, with the greater improvement taking place first on the left side and in the distal joints of the limbs. The overactivity of the deep reflexes diminished, the clonus phenomena were lessened, and the abnormal responses to cutaneous stimuli underwent a similar change. *Sensation* on the whole returned more slowly than motor functions. There was, however, some improvement in sensation within the first 24 hours, and this brought into clearer relief the difference, which had been observed before the operation, between the distribution of the defective cutaneous and deep sensations. Thus, the perception of all cutaneous stimuli (touch, pain, and temperature) improved markedly on the left side but not on the right, while the recognition of passive movement of the limbs became more accurate on the right side but remained wholly impossible on the left. After a few hours of pronounced vasomotor disturbances, with elevation of temperature and a recorded axillary temperature that was 1 degree F. higher on the right than on the left side, all of the disturbances of the autonomic nervous system diminished. The left pupil became nearly as large as the right, although the left enophthalmos continued noticeable for nearly 10 days.

Seven days after the operation the improvement in voluntary motion had become striking; the Babinski reactions were negative; the deep reflexes upon the left side alone were still hyperactive; and clonus was very inconstant. There was improvement in all of the sensory responses, but the sensory dissociation was still marked.

Fourteen days after operation, the patient wrote her first letter and walked a few steps with assistance. In everything except position sense on the left side, there now was marked improvement; and this one defect continued relatively unimproved, even at the time of her discharge. Of the involuntary reflexes already described, only the tendency to finger clonus in the left hand now persisted; but certain new observations were made of reflex hyperexcitability in this region, i.e., involuntary contraction of adjacent fingers when any one finger was forcibly extended, involuntary flexion of the thumb on forceful flexion of the middle digit (Mayer's reflex), etc.

On October 3, cutaneous sensation was normal on the left side and had shown marked improvement in the right arm, although not in the right leg. Sense of position was normal on the right, but still seriously impaired on the left. The patient walked freely, dressed herself, fed herself, and wrote with fair ease. She did not feel up to her normal strength, however, and all of these activities fatigued her. Involuntary reflexes had almost disappeared from the arms, although they still persisted in the left hand. The Babinski responses were usually negative on both sides, although an equivocal response could sometimes be obtained from the left foot. A poorly sustained ankle and patellar clonus was still to be observed on the left but not on the right; and although there was no crossing of reflex responses from the left to the right side, stimulation of the right patella caused slight contraction of the left adductors. The defensive reflexes had almost disappeared. Finally, it was striking that the left Achilles tendon was still acutely sensitive, while the right was almost anæsthetic; so that it is evident that deep pain follows cutaneous pain pathways and not those of deep position sense.

October 12: The patient was discharged. At that time she was making slow but steady progress. In her final examination it became clear that there was, associated with her defective muscle and joint sense on the left side, a marked impairment of two-point discrimination and an almost total astereognosis.

Both of these sensory functions were unimpaired on the right side.

On February 11, 1928, the patient reported that she had been back at her old position as stenographer for 2 months but that she still became fatigued easily, and that her left arm, hand, and leg were a little weak and clumsy. In walking, her balance was still slightly insecure and she continued to use a cane. Neurological examinations by local physicians showed that the left abdominal reflexes were still absent, that the knee-jerk on the left side was still exaggerated, and that there was a tendency to ankle clonus on the left. Earlier reports from the patient had showed that the astereognosis on the left side was improving.

In a later report written on March 8, 1928, she states: "My walking has greatly improved. I can walk quite a little faster and am much more sure on my feet, and use the cane only when it is extremely slippery. I seem to have a great deal more confidence in my ability to stand on my feet, but I do stagger a little occasionally; that is, I am apt to lose my balance if I do not watch myself, but as other people also notice that I walk better, and I do myself, I know there is an improvement. I am waiting anxiously for spring and clear sidewalks.

"Last night I went through the test of identifying objects in my left hand, and was able to name every one. I believe there were about a dozen. I am able to move things around in my hand and thus feel of them with my fingers, which of course makes it much easier to identify them. I do not believe that my hand is yet back to where it was before this last illness, but it is becoming more useful all the time, and if I could but walk all right, I would not complain at all. We also tried hot and cold glasses on my legs. Of course in the left leg I could tell both heat and cold immediately, but in the right, the sense of heat was still a little hazy, although I could tell the cold glass at once. That sense of feeling also had improved over the last time. I was also able to tell every direction that my toes were moved in, except once in the left foot I missed, but evidently my sense of movement in that foot is improved. So taking it all in all, I consider that there is a decided improvement. What do you think?

"I still have the pain between my shoulders and in the back of my neck when overtired, but never unless I have worked too hard. I really feel that I can not ask for shorter hours, as I work only from 8:45 A.M. to 5 P.M. with an hour and a half for lunch, and I feel that they pay me too well and have been lenient with me for so long that I must get all the work done that there is to do, and I do not believe that I will have it when I have gotten stronger. I am sorry that I can not report any loss of weight; I am afraid I am not very good at dieting, etc."

DISCUSSION OF THE PRE-OPERATIVE AND POST-OPERATIVE COURSE OF CASE 2

In this attack, as in the earlier ones, the paralysis appeared first and persisted longest on the left side. Nevertheless, during the height of the process, it was the right side which showed the more profound loss of power. The left side also showed, from first to last, more marked reflex hyperexcitability than the right. The explanation which naturally suggests itself for these seemingly paradoxical facts is that the right side suffered the more recent injury and hence manifested the flaccidity of "spinal shock," while on the left side we were presumably dealing with a condition of chronic impairment of the upper motor neurones, spinal shock having long since passed off.

The distribution and recovery of sensory impairment were particularly instructive. There is much confusion in the clinical literature concerning the Brown-Séquard syndrome. In his *Course of Lectures on the Physiology and Pathology of the Central Nervous System*, delivered at the Royal College of Surgeons in England in May, 1858 (Philadelphia, 1860), Brown-Séquard deals at length with his experiments upon hemisection of the cord in animals and discusses the clinical correlations of his physiological observations. Here he describes clearly the effects of transecting half of the cord below the decussation of the pyramids (e.g. high in the cervical level). Thus, on page 111, he says: "In a spinal cord an alteration in a lateral half produces hyperæsthesia and paralysis of movement in the corresponding side, behind the place of the alteration (that is, caudal), and the loss of sensibility without the loss of movement in the opposite side (see 3, Fig. 21)." Again, on page 200, he says: "Below the decussation of the pyramids a lesion in (half) the spinal cord produces paralysis in the same side and anæsthesia in the opposite side." This is the simplest manifestation of the Brown-Séquard syndrome. A usual correlation, which was apparently not recognized by Brown-Séquard, or at least is not mentioned in his work, is the loss of position sense on the same side as the lesion. Further analysis of the syndrome has been given by many subsequent writers, notably Schittenhelm (28), Fuernrohr (13), and Kron (22).

This patient showed clearly this classical dissociation: her paralysis appeared first on

the left side, whereas the defective cutaneous sensibility was first noticed on the right. During the height of her illness, the picture was recognizable, although somewhat confused; but again during her convalescence and at discharge, the fundamental distribution of symptoms was in accordance with the classical law. Her chief motor weakness was again on the left side, and her reflexes were exaggerated on the left. On the right side, her motor power was practically normal, but there remained a marked diminution in the acuity of her responses to pain, temperature and touch. Furthermore, muscle and joint sense, the fibers of which fail to cross within the cord itself, was defective on the side of the greater motor difficulty (left).

Despite the loss of kinesthetic and postural sensations from muscles, tendons and joints of the left side, painful sensations from these structures (as from pinching the Achilles tendon) were acutely perceived; on the right side deep pain was markedly diminished along with cutaneous pain. The fibers which mediate deep pain must therefore run in close proximity to those of cutaneous pain. It is significant that even with normal acuity of the sense of light touch on the left side, the patient had nevertheless a high degree of "posterior column astereognosis" and a marked loss in power of discriminating two points.

Careful analysis of this patient's postoperative course shows that the various sensory and motor functions returned *in the reverse order from that in which they disappeared.* The left arm (though affected early) was the last to become *completely* paralyzed and it was the first to come back following operation. Similarly the left side was the last to become numb to pinprick and its sensation returned very much sooner than did the right. This indeed one would expect on *a priori* grounds.

It is also significant that throughout her period of recovery, *motor* functions tended to return more quickly than sensory, and of the components of sensation the slowest to recover completely were the more highly developed qualities of sensation, such as light touch and the ability to perceive the texture of materials. Pain, on the other hand, returned more rapidly. This is important, for it is known that pain is mediated by fibers of small diameter, and these, being less susceptible to compression than larger fibers (Gasser and Erlanger, 16), are likely to be less affected by a tumor than the larger fibers which mediate muscle sense and other of the more highly discriminative qualities of sensation. It may be emphasized also that pressure upon bundles of conducting nerve fibers, such as those of the optic nerve and spinal cord, may serve to interrupt the passage of impulses without destruction of the structures themselves.

THE GENESIS OF THE CYSTS

Both cysts were lined by ciliated columnar epithelium, with a subjacent layer containing mucous, and probably also, serous glands. The wall of the cyst from the two-year old infant had remained fairly simple: connective tissue, blood vessels, a little smooth muscle, a few nerve fibers, and occasional polymorphonuclear neutrophilic leucocytes were all that could be found. The cyst from the 27-year old patient, with a history of four or five attacks due evidently to increase in size of the cyst with resulting compression of the spinal cord, had a more complex wall. Here, the smooth muscle was well developed and abundant, and patches of cartilage had also formed. There was evidence of recent infiltration with polymorphonuclear leucocytes, and of a more longstanding accumulation of lymphoid cells, not unlike atypical lymph follicles. There were also nerve fibers and possibly a few ganglion cells.

The classification of these cysts depends, in part, upon which, of all of these elements, are held to be part of the primary heteroplasia, and which are looked upon as accessory supporting or inflammatory adjuncts. Certainly the ciliated epithelium and the glandular elements are part of the primary tumor, and it is difficult to regard smooth muscle and cartilage as purely "reactive" in origin. The cysts must therefore be looked upon as teratomatous in nature.

There has long been a feeling of uncertainty as to the nature and origin of cysts which are lined with ciliated cells. Within the skin itself

ectoderm rarely gives rise to cysts containing ciliated cells. Hess (18) has reported one case. For the most part such cysts arise only in case an entodermal vestige (branchial clefts, neurenteric canal, etc.) is the probable source of the tumor (Mallory, 23). The morphological similarity of the linings of such cysts to the epithelium of the upper respiratory tract and of the fetal gut has impressed many observers; and when, as in these two cases, mucous and serous glands have developed, the analogy—particularly to respiratory epithelium—becomes even more striking. It is nevertheless difficult to understand how a true implantation of entoderm can occur on the lower cervical or upper lumbar region of the spinal cord. One is, therefore, forced to consider alternative interpretations.

The second possibility which suggests itself is that the cysts were formed, during the closure of the neural tube, by a fortuitous infolding of ectodermal cells. One must recall, however, that the ordinary dermoid or epidermoid cyst of the central nervous system is lined by stratified squamous epithelium, the central cavity of the cyst containing a mass of desquamated fatty cells and often cholesterin (whence the name "cholesteatoma"). As is well known, such cysts may also contain hair; their surface, moreover, is often pale, hard, and glistening—which condition has given rise to the other name current for such neoplasms, *Tumeurs Perlées*. With these tumors the two cysts described here have little in common (see Bailey, 3; Bailey, 4; Cushing, 7; Horrax, 21).

A third alternative is that our cysts represent ciliated fetal ependyma. Although the successful outcome of the operations made it impossible to establish the inner relationship of the cysts to the central canal of the spinal cord, the direct connection of the cysts with the surface of the cord suggests that they might have arisen by an extramedullary outpocketing of the central canal—an extramedullary syringomyelia (see André-Thomas and Quercy, 1). This neurogenic interpretation receives some support from the finding of a clump of what appear to be ganglion cells in the wall of cyst 2, and of bits of nerve fiber in both. However, no glial elements were present, and such an explanation fails to account for the presence of mucous and serous glands associated in normal structural relationship with an ependymal derivative.

The final possibility acknowledges our inability to make any of the preceding theories harmonize with all of the facts, and suggests merely that any type of fetal epithelium, whatever its origin, may, under special unknown circumstances, develop columnar epithelium possessing cilia. If this is the case, the effort to find close analogies in adult tissues is obviously useless.

Though inclined toward the last of these various hypotheses, we find ourselves quite unable to make a definite choice without the further information which could be gained only at necropsy. The cysts may, therefore, be looked upon as teratomata with entodermal epithelium and glands, to which have been added ectodermal elements (nerve fibers) and mesoblastic structures; or they may be thought of as dermoids which, for unknown reasons, have undergone a type of epithelial and glandular development, which is rare in the central nervous system, and which have added a mesoblastic component; or, finally, they may be interpreted as ependymal in origin, with epiblastic (glandular) and mesoblastic additions.

LITERATURE

A careful search of the literature has revealed no record of cases which are exactly comparable to the cysts reported here. A few instances of tumors have been gathered together, however, because they have features which suggest analogies to these two cases.

In 1866, Eberth (9) described a cyst imbedded in the occipital lobe of the left hemisphere. The cyst was club-shaped, and the narrow canal of the "handle" stretched toward the occipital pole of the posterior horn of the lateral ventricle, finally merging with the ependyma of the ventricle by a solid stalk. This cyst was lined by a columnar, ciliated epithelium; and Eberth believed it to be a heterotopic bit of ventricle in which the ependyma had retained its fetal cilia. He comments that as frequent as are cysts in the brain, with a lining of flattened, pavement

epithelium, so rare are cysts with a columnar, ciliated lining.[1]

In 1887, Strassmann and Strecker (29) described a polycystic tumor of the choroid plexus of a three-year old boy. The cyst walls contained ganglion cells, nerve fibers, glia, connective tissue, smooth and striated muscle, hyalin and fibrous cartilage, bone, fat, acinous and tubular glands, with cylindrical epithelium, blood vessels, and hæmorrhage. The cysts were lined by single-layered and stratified epithelium, and in some instances the epithelium was ciliated. Presumably this latter type of epithelium was composed of columnar cells, but the structure of the epithelium of the cyst as a whole is not made clear. Nor is it clear whether the glands were of the type of mucous glands.

In 1894, Arnold (2) described an anomaly which was found at autopsy in a child that died shortly after birth. There was a spina bifida with a huge, double external cyst. The inner cyst was composed of a myelomeningocele, the wall of which contained nerve cells and glia, muscle, fat, glands, and cartilage. The cyst was lined with cylindrical epithelium, which was continuous with the ependyma of the central canal. The presence of neural elements in the wall of a myelocele, is, of course, to be expected; and the accompanying development of mesoblastic tissue might well be interpreted as a response to the need for support of this anomalous structure. The presence of gland-like elements, however, suggests a relationship to our two cases, especially to the child with the spina bifida occulta. Unfortunately the exact nature of these glands is not made clear.[2]

In 1896, Saxer (26) described a large, nodular and cystic tumor which was found in the third ventricle of a 7 weeks old child, attached only to the tela chorioidea. This tumor contained neural elements, epidermal elements (glands, cysts, etc.) muscle, and cartilage. The exact nature of the cyst epithelium and of the glands is not made clear, but the occurrence of such a tumor at this point of mid-dorsal closure of the neural tube is in many ways analogous to the two cysts described in the present report.

Rosenthal, in 1898 (24) described an intramedullary tumor which he called a neuroepithelioma gliomatosum microcysticum. The tumor was in the lower dorsal cord and seemed to have connections both with the central canal and with the meninges. It contained multiple cysts and canals which were lined by cylindrical epithelium, on the free border of which occasional cilia were seen. The tumor terminated above in gliosis, and below in gliosis and a syringomyelia of the central canal. The cells lining some of the cysts suggest ependymal derivation; but other cysts, as seen in the illustrations, are gland-like "with albuminous contents" (Rosenthal). Whether this tumor is in any sense analogous to the two under discussion here is doubtful because of its intramedullary position, but the gland-like appearance of some of the cysts and the meningeal attachments make it possible that it could be a similar tumor which has become infolded within the cord itself.

In 1898, Fraenkel and Benda (11) described a group of multiple cysts which seemed to arise from the meninges, but which nevertheless were lined by an epithelium which suggested ependyma. It is not clear whether these cysts actually attached to the cord itself.

In the same year, Trachtenberg (30) reported a case which is relevant only because it affords a sharp contrast to the essential structure of these two cysts. The patient had multiple tumors of the arachnoid, over the dorsal surface of the cord from the cervical region to the cauda equina. These tumors were small nodules, containing a soft, yellowish pulp within a thin wall. The thin walls were made up of connective tissue without epithelial covering, smooth muscle, fat, balls of horny epithelial cells and sebaceous glands. These glands were lined by stratified squamous epithelium: only two small glands were seen, near the others, with columnar epithe-

[1] A similar cyst has just been reported by Fulstow (14) as an accidental finding in a man who had a hypophyseal tumor as well. We have also lately had a boy of 6 from whose third ventricle region cystic fluid containing ciliated cells was aspirated during a transfrontal exploration for a presumed suprasellar tumor. The fluid evidently came from a hypophyseal cyst, but as the lesion was inaccessible no tissue was obtained for verification. The child recovered and has since done well (P.B.B.H. Surg. No. 30037). It is not yet clear whether such suprasellar cysts containing ciliated cells are ependymal in origin or whether they represent a nasopharyngeal anlage.

[2] References to a few earlier reports of complex teratomatous tumors variously associated with spina bifida are given by this author. None of these, however, parallels our two cases.

lium but without clear lumina. The author believes these to be typical multiple dermoids of the central nervous system; and they show the structure which is characteristic for the usual dermoid tumors of this region in contrast to the tumors reported here. Similarly Hale-White and Fripp's (17) dermoid (containing stratified epithelium, sweat glands and hair follicles) at the third dorsal level has little in common with our cases. Herzog's (19) ependymal cyst of the cerebellum did not contain ciliated cells.

In 1902, Saxer (27, Case 3) reported another tumor of the leptomeninges, which filled the lower lumbar and sacral canal with a large, jelly-like cystic mass which was lined by papillæ of tall epithelial cells. Any connection with the cord is not clearly demonstrated, but the author suggests a possible origin in the filum terminale and believes that the epithelium may be ependymal in nature.

In 1904, Bittorf (6) described in the dorsal cord of a 55-year old man a tumor which lay in the subarachnoid space attached to the spinal cord. It was cystic, and was lined by cubical or cylindrical epithelium which was stratified at places. A cuticle, or possible cilia could be seen (the material was imperfectly fixed in formalin). The cysts were in continuity with syringomyelic cavities within the cord. At a slightly lower level of the cord a neuroma-like nodule was seen, which recalls the similar associated defect which was observed at operation in the first of our two cases.

André-Thomas and Quercy (1) reported a similar case in 1912, but unfortunately no clinical details were available. A cyst communicating with the central canal of the spinal cord at the 5th or 6th cervical level (causing the cord in this region to be extremely flattened) was found to contain glial elements (superficial), connective tissue, striated muscle, many blood vessels, and was lined with typical polyhedral ependymal cells, but no mention is made of their being ciliated. There was also a dilatation and gliosis of the central canal from the cervical to the lumbar region.

Bielschowsky and Unger (5) describe (with full clinical details) a somewhat similar case of extensive gliosis and syringomyelia associated with a teratomatous area in the upper cervical cord, which contained ingrowing hairs with foreign body giant cells and several small cysts lined with skin-like epithelium. The case came to necropsy following operation and was carefully studied.

Frazier (12, p. 513) mentions having operated on one teratoma and two dermoids of the cord, and Elsberg (10, p. 248) states that he removed a spinal cord "cyst" but no clinical or pathological details are given concerning any of these four cases.

Finally, without venturing any answer, the question may justly be raised whether these cysts have any relationship to the papillomata of the choroid plexus, described by Davis and Cushing (8). One must allow for the fact that the papillomata arise within the ventricle and develop an abundant villous-like structure, whereas these cysts, if pushed outward from the canal, could develop only a limited papillary infolding within the confines of the tense and distended sac. Nevertheless, except for the lack of cilia, there are striking resemblances in the cell morphology and granulation of the epithelial layer of the papillomata and of the cysts. Moreover, it is striking that it is in tumors of the choroid plexus or tela chorioidea which have attained a somewhat more complex structure than these described by Davis and Cushing (i.e., those of Strassmann and Strecker, and of Saxer, 1896, q.v. above) that malformations most closely resembling our two cysts have been reported. In any case, it seems justifiable to conclude that the whole line of dorso-medial closure of the neural tube is a region in which a teratomatous or dermoid tumor of the central nervous system may form, which is unlike the usual dermoid of this organ in that it may contain a ciliated epithelium resembling fetal ependyma, elements which are clearly neural, and other quite unrelated structures, such as glands, smooth muscle, and cartilage.

SUMMARY

Two cases of teratomatous cysts of the spinal cord are described, which were successfully removed at operation. Both contained ciliated cells. The first patient, a

child of 2 years, who came under observation because of irritability and "tender" abdomen, gave a history of always having dragged its right foot. Repeated lumbar punctures at tenth-eleventh dorsal vertebræ level gave thick "egg-white" fluid filled with ciliated cells. At operation a large flattened cyst was found extending from tenth dorsal to fourth lumbar vertebræ. Histologically it proved to be a relatively simple teratoma lined with ciliated columnar epithelium. The child recovered and became symptom-free.

The second patient, an unmarried female American of 27, had had five attacks of left hemiplegia with pain in left cervical region and Brown-Séquard dissociation of sensation in trunk and extremities (pain and thermic sense absent on the right, loss of position sensation on left with astereognosis) at varying intervals since the age of two. Her present attack developed into an almost complete quadriplegia with an upper level of sensory disturbance at fourth cervical and grave embarrassment of respiration. Dr. Cushing removed a cyst filled with mucus and ciliated cells attached to the left side of the cord at the third-fourth cervical vertebræ level. Histologically this cyst was found to be a more complex teratoma than the preceding, with changes compatible with its greater age. After operation, patient had an immediate and dramatic recovery of power with marked though less complete return of sensation. Both cysts were congenital and probably represent ependymal diverticula of the central canal of the spinal cord.

BIBLIOGRAPHY

1. André-Thomas and Quercy. Syringomyélie hyperplasie du tissu conjoncif, fibres musculaires striées dans la moelle. Nouv. Icon. de la Salpêt., 1912, xxv, 264–383.
2. Arnold, J. Myelocyste, Transposition von Gewebskeimen, und Sympodie, Ziegler's Beitraege, 1894, xvi, 1–17.
3. Bailey, P. Cruveilhier's Tumeurs Perlées. Surg., Gynec. & Obst., 1920, xxxi, 390–401.
4. Bailey, P. Further observations on pearly tumors. Arch. Surg., 1924, viii, 524–534.
5. Bielschowsky, M., and Unger, E. Syringomyelie mit Teratom- und extramedullarer Blastombildung zur Kenntnis der Pathogenese der Syringomyelie. J. f. Psychiat. u. Neurol., 1919, xxv, 173–218.
6. Bittorf, Al. Beitraege zur pathologische Anatomie der Gehirn- und Rueckenmarkgeschwuelste. Beitraege, 1904, xxxv, 169.
7. Cushing, H. A large epidermal cholesteatoma of the parieto-temporal region deforming the left hemisphere with cerebral symptoms. Surg., Gynec. & Obst., 1922, xxxv, 557–566.
8. Davis, L. E., and Cushing, H. Papillomas of the choroid plexus. Arch. Neurol. & Psychiat., 1925, xiii, 681–710.
9. Eberth. Flimmerepithelcyste im Gehirn. Arch. f. path. Anat., etc., 1866, xxxv, 479–480.
10. Elsberg, C. A. Diagnosis and Treatment of Surgical Diseases of the Spine and its Membranes. Philadelphia: W. B. Saunders Company, 1916.
11. Fraenkel, A., and Benda, C. Zur Lehre von den Geschwuelsten der Rueckenmarkshaute, u. s. w. Deutsche med. Wchnschr., 1898, July 28, p. 476.
12. Frazier, C. H. Surgery of the Spine and Spinal Cord. New York: D. Appleton & Company, 1918, 971 pp.
13. Fuernrohr, W. Ein Fall von Brown-Séquard'scher Halbseitenlaehmung. Deutsche Ztschr. f. Nervenh., 1902, xxii, 15–23.
14. Fulstow, M. An epithelial cyst of the hypophysis. Am. J. Path., 1928, iv, 87–93.
15. Fulton, J. F. Observations upon certain spinal reflexes of man, and their relation to the tonus of skeletal muscle. J. Nerv. & Ment. Dis. (in press).
16. Gasser, H. S., and Erlanger, J. The differential action of pressure on fibers of different sizes in a mixed nerve. Proc. Soc. Exper. Biol. & Med., 1927, xxiv, 313–314.
17. Hale-White, W., and Fripp, A. B. A case in which the attempt was made to remove a dermoid tumor. Tr. Clin. Soc., London, 1900, xxxiii, 140–145.
18. Hess, K. Ueber eine subcutane Flimmercyste. Ziegler's Beitraege, 1890, viii, 98.
19. Herzog, M. Eine eigenartige Ependymcyste im Kleinhirn. Centrlbl. f. Path., 1899, x.
20. Herzog, M. Acta Path. et Microbiol. Scand., 1926, Supp. vol. i.
21. Horrax, G. A consideration of the dermal versus the epidermal cholesteatomas having their attachment in the cerebral envelopes. Arch. Neurol. & Psychiat., (Sept.), 1922, viii, 265–285.
22. Kron, J. Experimentelle Beitraege zur Lehre von der Hemmung der Reflexe nach halbseitiger Durchschneidung des Rueckenmarks. Deutsche Ztschr. f. Nervenh., 1902, xxii, 24–53.
23. Mallory, F. B. Sacro-coccygeal dimples, sinuses, and cysts. Am. J. M. Sc., 1892, ciii, 263–280.
24. Rosenthal, W. Ueber eine eigenthuemliche, mit Syringomyelie complizierte Geschwulst des Rueckenmarks. Ziegler's Beitraege, 1898, xxiii, 111.
25. Sabin, F. R. Studies of living human blood cells. Bull. Johns Hopkins Hosp., 1923, xxxiv, 277.
26. Saxer, Fr. Ein zum groessten Theil aus Derivaten der Medullarplatte bestehendes grosses Teratom im iii. Ventrikel eines 7-woechentlichen Kindes. Ziegler's Beitraege, 1896, xx, 399.
27. Saxer, Fr. Ependymepithel, Gliome, und epitheliale Geschwuelste des Centralnervensystems. Ziegler's Beitraege, 1902, xxxii, 276.
28. Schittenhelm, A. Ueber einen Fall von Stichverletzung des Rueckenmarks. Deutsche Ztschr. f. Nervenh., 1902, xxii, 1–14.
29. Strassmann, F., and Strecker, C. Ein Teratom in rechten Seitenventrikel. Arch. f. path. Anat., etc., (May) 1887, cviii, 351.
30. Trachtenberg, M. A. Ein Beitrag zur Lehre von den Arachnoidealen Epidermoiden und Dermoiden des Hirns und Rueckenmarks. Arch. f. path. Anat., etc., 1898, cliv, 274.

ORIGINAL FEATURES IN ARTHROPLASTY OF THE KNEE WITH IMPROVED PROGNOSIS[1]

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TO the patient with bony ankylosis of the knee, a functioning joint with adequate mobility and stability is his object in seeking an arthroplastic operation. Whether or not the surgeon follows anatomical contours in modelling the new joint does not interest him, so long as the joint *functions*. It has been found by Allison and Brooks that it is absolutely impossible to duplicate experimentally, or in surgically constructed joints at the knee, the normal gliding of the articular bone surfaces. This being true, and as attempts to approximate the contour of the normal joint are so often followed by lateral instability, I have devised a technique based on well known mechanical principles which ignores the normal contours of the joint, and provides both mobility and stability. It has given excellent results in 10 cases.

In the bone-modelling, wide V-shaped incisions replace the usual attempts to follow normal bony contours when viewed anteriorly (Fig. 1). The convex wedge-shaped plane surfaces of the femur fit accurately into the concave wedge-shaped plane surfaces of the tibia. Weight-bearing forces the apex of the wedge-shaped end of the femur so firmly into the tibia that the danger of lateral instability is practically eliminated, and a definitely improved prognosis is afforded.

At the Sixth Congress of the International Society of Surgery held in London in 1923, arthroplasty was one of the major subjects of discussion, and it is noteworthy that opinion was at that time divided between those who still believed arthroplasty of the knee to be extremely hazardous and those who felt that the field for its use was definitely enlarging—that to undertake it in carefully selected cases should no longer be regarded as indication of undue surgical boldness.

Eight countries were represented in this discussion:

Italy, Putti; France, Tuffier, Leriche, Santy; England, Hey Groves; Ireland, De Courcy Wheeler and Stoney; Czecho-Slovakia, Jira'sek; Spain, Ribas-Ribas, Sureda and Corachan; Poland, Jurasz, a former pupil of Payr; and America, MacAusland. Many good results were reported by Putti, and MacAusland suggested certain changes in technique. Jones and Lovett in the same year stated that the operation was still on trial (7).

Up to 5 years ago, my own attitude concerning arthroplasty to produce mobility in bony ankylosed knees (fibrous ankylosis will not be considered in this paper) was one of great conservatism, both because of personal experience and because of observations which I had made upon several of Dr. Murphy's cases of arthroplasty which had subsequently come to me, before and after his death. These patients either had insufficient motion to satisfy them, or more often the degree of mobility was satisfactory but lateral instability was present and proved so troublesome as to offset the advantages of mobility. In view of such results following Murphy's excellent technique and of my experience with three personal cases prior to 1920, I adopted the attitude that a patient would have to persuade me into undertaking an arthroplastic procedure upon the knee. In 1920 I devised the technique described and applied it to two cases with good results between 1920 and 1922; nevertheless, I kept a conservative attitude until 1923 when a patient (Case 3) for whom I had done an arthrodesis 4 years earlier for old tuberculosis of the joint returned and begged me to perform an operation to give her motion. Her parents were equally urgent in their plea.

The tuberculosis had existed since the patient was 17 months of age. The arthrodesis had been performed when she was sixteen. At this operation the posterior part of the patella, the infected posterior portion, had been sawed away, and the rest of the patella left with one-half of its posterior cut surface in contact with the femur and one-half with

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the tibia, for the purpose of supplementing bone growth and of acting as a pedicle graft in producing the ankylosis. This procedure was contrary to the older methods in which the patella was enucleated, but proved very fortunate when the subsequent arthroplasty was attempted.

If ever my position was one of demanding persuasion to do an operation it was in this case, as I was fully aware of the danger of causing a relapse of the old tuberculosis as well as of the unfavorable prognosis in arthroplasty of the knee. Both patient and parents were, however, so persistent in their request that I finally consented to operate, but only after assurance by all that I would be absolved from any responsibility or blame if the tuberculosis relapsed or the result of the operation proved unsatisfactory. Quite contrary to my expectations the result was excellent. There was adequate mobility and no lateral instability (Figs. 9, 10, 11).

In the light of the good result in this case, my point of view regarding arthroplasty of the knee changed considerably, and I have since operated on 7 cases with good results, making a total of 10 cases.

With proper selection of cases, meticulous attention to technique, and intelligent postoperative physiotherapy, I believe that the prognosis for arthroplasty of the knee is good. The technique devised in the two earlier cases (1920 and 1921) was used in the case just described and has been followed in all subsequent cases. It contains several original features which diminish the danger of lateral instability, and make the early application of physiotherapy possible.

AUTHOR'S TECHNIQUE

A tourniquet is applied well up on the thigh, so as to allow postoperative application of plaster of Paris before the tourniquet is removed.

The knee is approached by a U-shaped incision in the skin and soft parts from the inner and outer aspects downward to just below the tubercle of the tibia. It does not extend up the thigh as does Putti's incision. The concavity is upward. This U incision gives the surgeon absolute uninterrupted

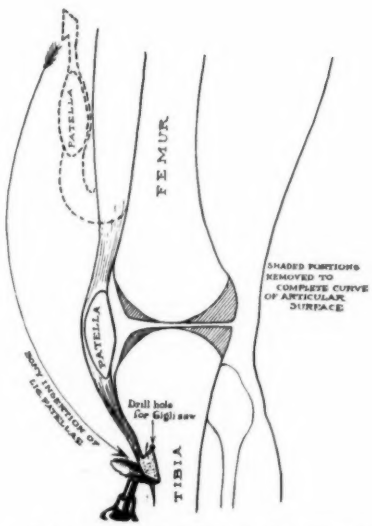

Fig. 1. Schematic drawing, lateral view, sagittal plane, showing author's method of turning up the ligamentum patellæ with its bony insertion, the patella, and the quadriceps tendon. Note modelling of the bony elements of the joint.

access to all the parts involved in the formation of the new joint, and is therefore distinctly superior to the lateral approach. Also it does not interfere with the important extensor apparatus above the knee, as is likely to happen with the inverted U incision or lateral approach.

The technique of arthroplasty should be so designed as to allow passive and active motion at the earliest possible moment without danger of separation of important structures. As the free gliding of the soft structures or "extensor apparatus" just above the knee joint is absolutely essential to free motion and active control, the severing and resuture of these structures, as in the inverted U incision, is to be avoided, for if they are severed, not only is there danger of union being insufficient when one wishes to start exercises and passive motion as early as 2 weeks after operation, but because of the cross section severance, there is danger of adhesions at this point between the gliding intramuscular and tendinous tissues. These considerations lead me to choose an incision which does not section or traumatize these soft structures

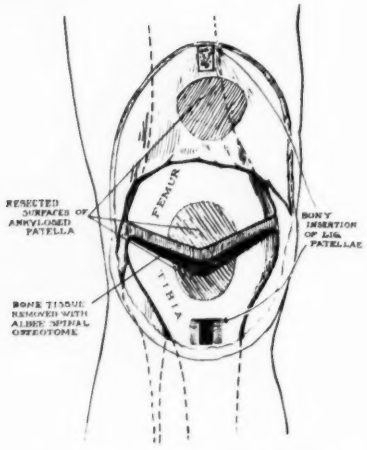

Fig. 2. Schematic drawing showing author's method of turning up the patella and ligamentum patellæ with its bony attachment at the tubercle of the tibia. Note the method of removal of bone by a broad V-shaped incision to make the new formed bony joint.

above the knee, and to turn the patella upward rather than downward, as advocated by certain authors.

When the knee is being opened up, care should be taken to leave the skin flap overlying the interior work as thick as possible, so that the skin and line of suture will not break down following operation.

Before the patella is turned upward, the ligamentum patellæ is detached with a generous amount of bone from the region of the tibial tuberosity, in the dovetail manner indicated in Figure 1. First two holes for later insertion of kangaroo tendon are drilled, one through the tibial tuberosity, and one slightly posterior to it. Then by means of the motor saw and small drill, the tubercle of the tibia, including one drill hole, is removed with the ligamentum patellæ, and the patella turned upward. This bone plastic work is done very rapidly with the Albee motor saw, and because of the dovetail mortice conformation and the rapid union of closely fitted broad bone surfaces to bone surfaces, the surgeon need not question the detachment of the ligamentum patellæ—a question which has been raised by MacAusland, who considers it inadvisable to sever or disturb the patellar tendon or its attachment. It is distinctly preferable to detach this tendon, as trying to work around it involves unnecessary trauma to neighboring tissue, slows up the operation, and limits access to the joint.

It is well known that bone unites to bone more readily and more firmly than tendon to tendon, or fascia to fascia. The author's method of detaching the ligament takes advantage of this, the dovetail mortice conformation being a further assurance of prompt union and of the prevention against the pulling away of the tendon from the tibia even when bony union has not taken place. Prompt union obviates delay in the application of postoperative physiotherapy, which should follow within 2 weeks after the arthroplasty. In marked contrast to this is the union of a severed tendon to tendon, which is both slow and unreliable. Putti's method of nailing the ligamentum patellæ and tibial tubercle in place with a double-headed nail does not insure as prompt or as firm union, and has all the disadvantages which attend the introduction of foreign bodies into living tissues. In reviewing the literature, I find that Kirschner has successfully used a method somewhat similar to mine.

After the ligamentum patellæ has been thus detached, the soft tissue and capsule are dissected from the ankylosed joint to which they have become amalgamated, and the whole mass—patella, quadriceps, and soft parts—turned upward, exposing completely the anterior and lateral surfaces of the junction of the tibia and femur (Fig. 1).

At this juncture the gliding of the lower part of the quadriceps muscle and its tendon upon the lower end of the femur is tested, as well as their length. If this tendon and muscle do not glide up and down satisfactorily and are not of sufficient length, plastic work should be done to lengthen the tendon as well as to bring about its satisfactory gliding on the lower end of the femur. This is a very important feature of the operation, because if the tendon is not long enough to allow postoperative flexion, or if the quadriceps tendon is not free, serious interference with postoperative physiotherapy or mobilization of the joint will occur.

Severance of the quadriceps tendon or muscle becomes unnecessary when my technique is used, and this is well since severance necessitates the suture of soft part to soft part, fascia to fascia, and muscle to muscle, thus tending to shorten these structures as well as to delay early physiotherapy by slow union. It has been my practice to remove all immobilizing splints at the end of 2 weeks and to institute active and passive motion. If the quadriceps tendon were severed, this early postoperative treatment would certainly jeopardize union. Again the severance of the quadriceps muscle and tendon and the dissecting downward of the distal portion seriously involve the gliding structures above the patella, which may not have been damaged or destroyed by the original pathology which produced the ankylosis.

After the patella, quadriceps, and soft parts have been turned upward *en masse*, one is then ready for the bone arthroplasty. It has been found by Allison and Brooks that it is absolutely impossible to duplicate experimentally, or in surgically constructed joints at the knee, the normal gliding of the articular bone surfaces. This being true, and attempts to approximate the contour of the normal joint being so often followed by lateral instability, it has seemed best to use one's mechanical ingenuity to bring about desirable functional results on an entirely different mechanical plan. Therefore, my technique does not follow the confirmation of the normal knee. By making use of well known mechanical principles, I have overcome the disadvantages with respect to lateral instability of an arthroplastic joint modelled after the normal anatomical joint, and still obtain adequate mobility.

With a broad osteotome parallel, broad V-shaped incisions with the apex downward are used in modelling the joint anteriorly (Fig. 2).

The lower end of the femur as viewed from its anterior surface is shaped into a wedge with an angulation of 120 degrees between its plane surfaces. This leaves the tibia with concave plane surfaces at an angle of 120 degrees to each other. These are in turn carefully modelled so as to receive with accurate fit the convex wedge-shaped surface of the femur. This is one of the original features of the operation, and is an effective measure in the avoidance of lateral instability, in that, from a mechanical standpoint, weight-bearing forces the wedge contour of the lower end of femur into the corresponding wedge shaped cavity of the upper end of tibia. This peculiar contact practically insures stability, and consequently an unusual amount of laxity can be permitted by removal of an ample amount of bone. A generous amount of bone, particularly at the posterior part of the joint, is removed from what was the tibia and femur, and the remainder is so shaped that it will imitate so far as possible the normal contour of the joint. However, even more bone is removed from the posterior condyles at this point. Great care should be taken not to leave any blocks of bone attached to soft parts in the popliteal space because of the danger of their acting postoperatively as osteogenetic material. It must be remembered, of course, that the removal of too much bone will favor instability, but the wedge-shaped method just described markedly diminishes this possibility.

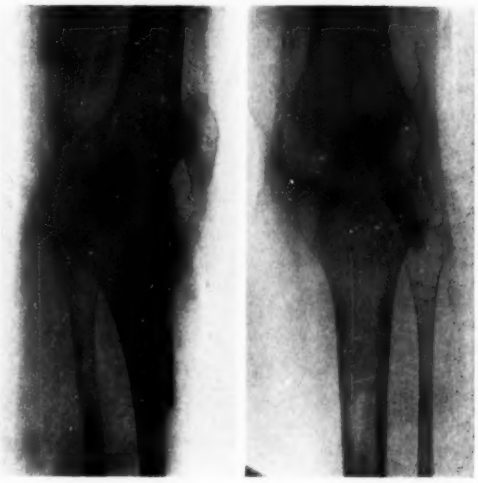

Fig. 3. (left) Lateral view showing author's method of erasion to secure arthrodesis in a tuberculous joint, leaving the patella intact, as we realize that the latter is an important item in a new-formed joint following arthroplasty. Note strong bone-graft tibial pegs *in situ*.

Fig. 4. Anteroposterior view of the same case, showing location of strong tibial pegs taken from the same tibia, lower down, with the author's motor saw.

Figs. 5 and 6. X-ray pictures, Case 2, showing complete bony ankylosis.

Great care should be taken to leave the bony surfaces as smooth and plane as possible to facilitate gliding. This is usually best accomplished with a sharp (1½ inch) osteotome, but a file may be used, if necessary. A close study of the conformation of the bony surfaces of the new joint should be made in order to shape them most favorably for the function of joint motion. The proper conformation of the joint should then be tested by flexing the knee to beyond a right angle. Free motion without impingement at any point of one surface upon another should be striven for, before the free fascia and fat graft is obtained.

The patellar ligament with its dovetail bone fragment is then replaced in the original mortice bed and sutured down by kangaroo tendon through the prepared drill holes.

The joint is again flexed very cautiously to at least a right angle, to check up on the contours and to insure free excursion of the quadriceps tendon and muscle, so that postoperative physiotherapy will not be prevented from the securing of the desired motion.

The joint is then packed with hot saline compresses, while a rectangular graft of fascia lata and fat is being obtained from the central portion of the outer aspect of the thigh. Being a semifluid substance the fat under pressure after joint closure practically flows into the cavities and absolutely fills up all peri-articular dead spaces, thus preventing the formation of hæmatoma. For this reason the inclusion of fat with the fascia lata graft seems to me very valuable, and I cannot agree with those who advocate the use of fascia lata alone.

If sufficient fat can be obtained with the fascia, the superior portion of the graft is split, and the undivided portion placed between the tibia and femur. The fascial portion of the split end is turned upward and inserted between the lower end of the femur and the quadriceps tendon and the patella, while the fatty portion is turned downward and placed between the upper end of the tibia and ligamentum patellæ and the patella. The graft is sutured with chromic catgut No. 1 to the remains of the capsule and soft tissues. The remains of the capsule are then sutured medially and laterally with chromic catgut No. 1, and the skin closed with plain catgut No. 0, and sterile dressings applied.

Moleskin straps are applied medially and laterally to the lower leg for traction to obviate muscle spasm and consequent injury to the fascia lata transplant, by crushing between joint surfaces and also to keep the bone ends apart.

Then a cast is applied, so constructed as to allow for traction by means of the moleskin. The tourniquet is not removed until the plaster applied from below upward, has reached it. Certain surgeons remove the tourniquet before they close up the wound. This is to be condemned in that in an arthroplasty there are such broad surfaces of raw bone that the large amount of bone ooze cannot be controlled by ligature. Careful observation shows that a larger amount of bleeding will come from the cut bone surfaces than from the small blood vessels which will escape ligature if the tourniquet is left on. The compression and immobilizing effect of plaster of Paris with all joint spaces filled with the fat and fascia graft acts as a marked hæmostatic influence, and it is therefore preferable to leave the tourniquet on, thus preventing the very considerable oozing from the

bone surfaces which would occur, were it removed. The hazard of hæmatoma is a real one, and should be carefully guarded against.

A pulley and traction apparatus upon the bed must be ready for immediate application when the patient returns from the operating room. The patient is held completely under the anæsthetic until traction of 15 pounds is well established upon the limb. This is done to prevent muscle spasm which is likely to occur as the patient comes out from under the anæsthetic and which might cause the approximation of the bone surfaces and the crushing of the fascia and fat graft between the bone surfaces. The latter might be a real calamity, leading to re-ankylosis.

This traction is continued for at least 1½ months after the plaster is removed and massage begun. Even after the patient goes home, the traction is maintained throughout the night, although during the day the patient is allowed to walk with crutches, *without weight-bearing*, the latter not being permitted until at least 2 months after operation.

This technique has been followed in the 10 cases which are reported herewith.

To date approximately 500 arthroplasties of the knee have been reported in the literature, about one-third of these being for bony ankylosis. (Table I.)

ESSENTIALS IN TECHNIQUE OF ARTHROPLASTY

The essential features in the technique of arthroplasty are: (1) approach to the joint; (2) the freeing of the ankylosis; (3) thorough eradication of all soft parts which might favor re-ankylosis, such as pathological neoform tissues, synovial débris, cartilage, fibrocartilage, capsule; (4) meticulous modelling of the articular surfaces so as to allow free motion and at the same time avoid lateral instability; (5) interposition of a tissue capable of arresting osteogenesis and of maintaining the separation of the new-formed articular planes, and at the same time of stimulating a minimum amount of tissue reaction; (6) closure of soft parts with care as to apposition, so that there will be no leakage through the line of suture; (7) immobilization with traction; and (8) intelligent postoperative physiotherapy.

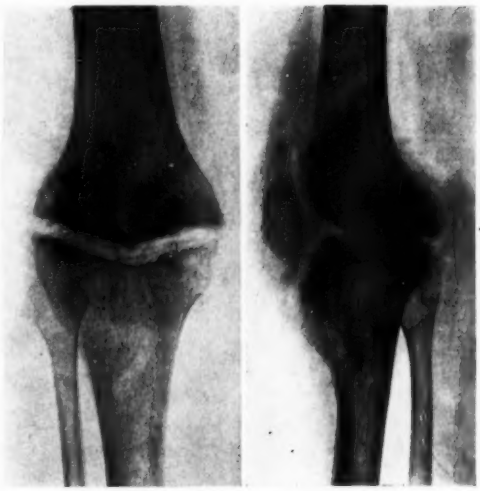

Fig. 7. (left) Roentgenogram following arthroplasty, Case 2, showing wide V-shaped method of removal of bone and shaping new-formed joint.

Fig. 8. Lateral view following arthroplasty, Case 2 showing modelling of joint.

A great variety of means are used by different surgeons to attain these fundamentals, modifications are made to suit the particular case, and experience with postoperative results suggests further modifications, such as those in the earlier part of this paper under "author's technique." In this connection it is interesting to review briefly the history of arthroplasty and the various methods now in vogue, since it cannot be said that there is at present any standard technique for this operation upon the knee.

To Verneuil (1863), Ollier (1888), and Helferich (1894) belongs the credit for the original conception of mobilizing ankylosed joints. Their procedure was of the nature of a resection rather than a true arthroplasty. Modern asepsis has made entering the joint and complicated technique less dangerous than in their day. Helferich is credited with the first success with the interposition method. Murphy and Putti have done much to perfect the technique. It is curious that although the idea of arthroplasty is essentially a French idea, France has until recently been one of the most conservative of its advocates, so far as the knee is concerned.

TABLE 1.—ARTHROPLASTIES OF THE KNEE REPORTED IN THE LITERATURE*

Author	Case	Good Results	Author	Case	Good Results
Alglave	1	?	Kirmisson	1	0
Baer	28	15	Larroyenne	2	2
Campbell	55	46	Le Fort	1	0
Ceballos	13	8	Lenormant	1	fair
Brocq	1	1	Leriche	4	3
Chevalier	2	fair	Lexer	79	60‡
Corachan	1	1	MacAusland	1	1
Cramer	10	6	MacCurdy	1	1
De Courcy-Wheeler	2	2	Mauclaire	9	2
Desmarest	3	2	Mayo Clinic (see Henderson)		
Delbet	1	?	Murphy	28	26
Deutschlander	2	1	Neff	2	2
Diel	1	1	Olgivy	1	1
Dourante	2	1	Osgood	6	0
von Eiselsberg	2	2	Payr	25	17
Euderlen	2	2	Puig Serada	3	0
Franke	2	fair	Putti	63	52
Gretschel	1	1	Rocher	1	0
von Hacker	4	0	Roth	2	2
Henderson	18	8†	Ryerson	10	1
Hey Groves	19	19	Schantz	2	2
Hintz	1	0	Schepelmann	2	fair
Hoffa	10	0	Schmertz	1	fair
Hoffman	1	fair	Stanischoff	3	1
Hubscher	1	fair	Tavernier	1	1
Ingebrigsten	1	1	Tubby	6	0
Kukula (Jira'sek)	13	10	Tuffier	1	1
Kirschner	1	0	Vedrene	1	1
			Wieting	3	3
			Wilmann	3	3
			Zaradnecky	1	1
			Total	460	
			Albee	10	9§
				470	

*No attempt is made to classify the cases from the literature as fibrous or bony as so many authors fail to state this point. The author's cases are all bony ankylosis.

† +3 fair ‡ +6 fair § +1 fair

In 1921, Ollier who had obtained very encouraging results from experimental arthroplasties on the knees of animals, hesitated to apply to human surgery what he had thus worked out, because of the consensus of opinion against such interference. But his own conviction in the matter is expressed by this question: "Is ankylosis in good position the last word in surgical art? Ought we ever to stop trying to attain on the knee what we obtain so routinely on the other joints: the shoulder, the wrist, the elbow?"

INDICATIONS AND TECHNIQUE FOR ARTHROPLASTY

Those who have had the widest experience and the greatest success with arthroplasty are unanimous in urging careful selection of patients. In so doing, the following points should be considered: (1) the original cause of the ankylosis; (2) the position of ankylosis (flexion, extension, hyperextension); and (3) the condition of the patient—not merely the general physical resistance, but the psychic, social, and occupational factors.

The original cause of ankylosis. Trauma, suppurative arthritis, gonorrhœa, tuberculosis, osteoarthritis, and rheumatoid arthritis are the usual causes of ankylosis, arranged in order of suitability for arthroplasties.

With regard to the advisability of operating upon a case of *bony ankylosis due to tuberculosis*, there seems to be the greatest difference of opinion. I believe such joints should be approached with due conservatism but not pessimism. Putti, Lexer, and Henderson consider it a definite contra-indication. Putti apparently bases his opinion entirely upon theory, as we have not been able to find a tuberculous case in his published series. Henderson has done an arthroplasty on two knees in which ankylosis was of tuberculous origin. Both of these were operated upon on a mistaken diagnosis. Neither gave a satisfactory result. Although he does not advise arthroplasty in tuberculosis of the knee, he has done successful arthroplasties on several cases of healed tuberculosis of the elbow joint. Murphy considered the prognosis unfavorable. Baer, Payr, and Hey Groves consider the prognosis good, *if the cases are properly selected*, and I subscribe to this opinion, one of my most brilliant results being in a case of old tuberculosis.

Chevalier believes that in general, since there is no way of proving absolute cure of tuberculosis, it is better to leave such cases alone; but that since there are reported in the literature a certain number of good results arthroplasty ought not to be absolutely rejected and is permissible in three instances: (1) In cases which have apparently been cured, if the patient insists on arthroplasty. (2) in cases which have apparently been healed for a long time and the knee is ankylosed in flexion. If on opening the joint, a tuberculous focus or suspicious looking tissue is found, a resection can be done, and the patient will be as well off as before. If no

Fig. 9.

Fig. 10.

Fig. 11.

Fig. 9. Active extension, Case 2, following arthroplasty.
Fig. 10. Postoperative view, Case 2, showing 90 degrees of active flexion.
Fig. 11. Showing weight-bearing on new-formed joint, Case 2, and demonstrating lateral stability.

lesion is found, arthroplasty will give the patient the chance of gaining mobility. (3) In cases in which arthrodesis has been previously performed. In such cases cure of the tuberculosis is most probable and when X-rays show that the ankylosed bone has sufficient dimensions to allow for arthroplasty, it seems most reasonable to attempt it, if the patient so desires. Payr has done this, and has tried to make up for the absence of the patella by special tendinous grafts. Although the results have not always been good, Chevalier finds them distinctly preferable to complete ankylosis.

I am in complete accord with points 1 and 3, but fail to see why ankylosis in flexion is a special indication for arthroplasty.

In determining the operability of tuberculous cases, the surgeon finds that careful X-ray study in several planes and by stereoscopic views serves as a very valuable and trustworthy adjutant; in fact X-ray technique has now been so perfected and reveals such excellent detail that if the surgeon makes the best of this opportunity in selecting cases and does not undertake arthroplasty until 4 or 5 years after the last symptom has subsided, he is fairly safe. If in the X-ray there are evidences of rarefied pockets or cavity formation, or areas of extreme osteoporosis, the case is unfavorable; but if the bone structure appears fairly uniform, arthroplasty should be successful.

It is needless to emphasize the fact that improvised tendinous grafts to take the place of the patella are certainly not as desirable as the retention of the patella at the arthrodesis operation for later utilization in arthroplasty.

For a long time in a large number of cases I have preserved the patella as a pedicle graft, mortised or brought it in contact with both tibia and femur to increase osteogenesis, and the results have been excellent so far as the arthrodesis was concerned. Now, since the new concept of preserving the patella for use in a future arthroplasty has appealed to me, if the patella is involved in the infection I remove only the small diseased portion, the remainder being allowed to remain *in situ* for future utilization.

In Table II are listed the end-results in 24 cases of arthroplasty on tuberculous knees which have been reported in the literature, and my case, which has already been described, and in which the result was excellent. I have also done an arthroplasty in several cases of healed tuberculosis of the hip, with good results.

The position of ankylosis. Extreme flexion is unfavorable to arthroplasty because it makes the technique very difficult and

Fig 12.

Fig. 13.

Fig. 14.

Fig. 15.

Fig. 16.

Fig. 12. Weight-bearing on newly-formed joint, Case 3.
Fig. 13. Postoperative view, Case 3. Note extensive scars from the prolonged osteomyelitis which led to ankylosis. Also active flexion.

Figs. 14 and 15. Postoperative view, Case 3, showing active flexion, 1½ years after operation.
Fig. 16. Postoperative view, Case 3.

necessitates extensive removal of bone and the sacrifice of that portion of the tibia and femur which has the largest diameter, thus tending to produce lateral instability. If the knee is markedly flexed, it is advisable to perform a preliminary supracondylar osteotomy.

The condition of neighboring joints should also be considered. If both knees are ankylosed, arthroplasty on one is definitely indicated; or if the knee and hip on the same side are ankylosed, there should be slight reason for hesitation.

To women the awkwardness of ankylosis is more annoying than to men, and in young women, ankylosis often proves a distinct handicap socially. For both men and women, the nature of their profession or occupation will often determine how essential mobility of the knee is to them.

Five years ago I would have said that ankylosis in extension was best left alone, but in view of the constantly improving results from arthroplasty, I believe that the patient should be given the benefit of the latter unless there are definite contra-indications.

Co-operation of the patient. In few operations is the absolute co-operation of the patient so essential as in arthroplasty of the knee. However perfectly the technique may be executed, a good functional result cannot be obtained unless the patient submits with patience, courage, and intelligence to the long postoperative treatment which is likely to be slightly painful in the first stages and is always tedious. It is wise to test the patient's nervous stability by telling him this in advance, and to let his reaction to such a statement be an indication for or against the operation.

All persons of weak will, those of excessive nervous instability, and those who have a litigation interest in not getting better, such as certain compensation and accident cases, must be eliminated if the surgeon does not wish to risk unnecessary failures.

Age and sex are not vital factors, although patients under 16 years are sometimes difficult to manage after operation, and those over 50 years have not the same degree of resistance. It has been stated by some authors that men are more favorable subjects than women, but this has not been my experience.

Incision. The incision should satisfy two conditions: (1) give free access to the most remote corners of the joint so that it may be meticulously modelled and bony débris cleaned out; and (2) preserve the juxta-articular elements, particularly the extensor apparatus above the knee, which is so important for future active mobility and stability.

Three types of incision are to be considered: (1) the lateral incisions used by Murphy and Baer; (2) the U incision with concavity downward; and the inverted U incision with concavity upward. The *lateral incisions* avoid severance of the quadriceps, but do not afford free access to the joint, particularly to the popliteal space; are apt to lead to necrosis of the soft parts due to the trauma from difficult instrumental retraction, and because

of the severing or traumatizing of the soft parts above the knee, may impair the extensor apparatus, which is so essential to motion. Murphy for a time abandoned this method for the U incision, but later returned to the lateral incisions. They are now rarely used, except by Baer.

The inverted U incision advocated by several authors, including Putti, and popular in France, is also objectionable in that it severs the extensor apparatus lying above the joint, entails suture of these soft parts and the possibility of slow union, which will delay postoperative physiotherapy; and further, adhesions in this location will interfere with the free gliding of the extensor apparatus, which is as important as motion in the joint itself.

The U incision with concavity upward is the incision of choice, since it affords free access to the joint and does not disturb the important extensor apparatus above it; and especially since the only objection to this incision can be removed by the simple dovetail osteoplastic method of turning upward the ligamentum patellæ, as employed by the author.

Treatment of the quadriceps. In many instances that part of the knee joint which extends above and posterior to the quadriceps tendon has not been seriously diseased, and the quadriceps tendon and muscle are neither shortened nor adherent to the lower end of the femur. In this event the excursion of the extensor apparatus is sufficiently intact so that no plastic work is necessary. In the event, however, of adhesions, scar tissue, or shortening of the quadriceps tendon and muscle, they must be overcome by plastic methods, and lastly it may entail the implantation of an extensive fat and fascia graft between the quadriceps tendon and femur.

If my method of approach is used, it is not necessary to lengthen the quadriceps routinely, and I recommend against it as it interferes with the extensor apparatus.

Treatment of the ligamentum patellæ. This point has already been discussed in detail under "Author's technique." The cutting of the ligament and later the suturing of it, as done by some surgeons, has obvious serious disadvantages in that the union of tendon to tendon is at best slow and not always firm. If the tibial tuberosity is taken with the ligament, the means of fixing it in place after it has been reimplanted have usually involved the use of foreign bodies, such as nails or screws, which are ill advised. The author's method of dovetail cabinet-maker's fit, made possible by motor instruments, has already been described. This method requires no foreign bodies for fixation purposes, and insures early union. Although I worked out this method independently, I find, on reviewing the literature, that Kirschner proposed in 1910 a similar method. The criticism has been

TABLE II.—END-RESULTS OF ARTHROPLASTY ON BONY ANKYLOSED KNEES OF TUBERCULOUS ORIGIN

Author	Case	Results
Albee	1	Excellent: 90° active flexion; full active extension; lateral instability.
Baer (6 on fibrous ankylosis of tuberculosis origin)	1	Good: 55°. (20 to 75° motion.)
Ceballos	2	1 good result.
Delbet	1	1 fistula and re-ankylosis. Patient did not co-operate; failure.
Diel	1	Improved.
Le Fort	1	Good.
Henderson	2	Unsatisfactory.
Hintz	1	Unsatisfactory.
Hubscher	1	Patella mobile; 30° flexion.
Ingebrigsten	1	Good.
Leriche	2	1 good. 1 slight lateral mobility; some retraction of quadriceps.
Payr	2	5° flexion. Excellent (80° to 90° flexion).
Putti	0	
Roth	2	1 satisfactory. Can get on tramway. 1—at end of 3 months, 60° passive flexion; 40° active.
Serada	2	1 after operation, good mobility; but genu valgum developed, which was treated by immobilization. When apparatus was removed, knee was re-ankylosed. 1 failure—suppuration.
Tubby	1	Failure.
Wieting	3	Good.
Total	24	11 good results.

Campbell, Putti, and Lexer consider tuberculosis a definite contra-indication to arthroplasty. Murphy, an unfavorable factor, but not a contra-indication; Henderson advises great conservatism. Payr and Baer consider healed tuberculous cases, properly selected, favorable. The author concurs with the latter opinion.

made in the literature that by Kirschner's method the mortising may not be sufficiently accurate or firm, and a fracture or pulling away may occur during the postoperative treatment. With the use of the motor saw, drill, and gigli saw, this possibility is entirely eliminated, for the work can be done quickly and easily, and the cabinet-maker's dove-tailed fit assures firm attachment or union before postoperative treatment is begun. The method is strongly recommended, as being distinctly preferable to the alternative—sectioning the quadriceps.

Freeing of the patella. With the chisel the patella is detached from the femur, the procedures described in the literature varying with the type of skin incision: half from without and half from within, if two lateral incisions are used; from below upward if the U incision is used; and from above downward in Putti's new procedure, the inverted U incision. Ceballos' vertical hemisection of the patella and quadriceps is rather too complicated, as the instruments must be inserted through the breach in the quadriceps. I advocate turning the patella upward, because this does not traumatize the extensor apparatus above the patella.

Cleaning of the freed joint must be most painstaking, with removal of all fibrous elements. In old bony ankyloses often no vestige of the menisci is found, nor of the crucial ligaments which have become absorbed in the ankylosis. The capsule presents itself as an indistinct and adherent mass. The lateral ligaments may exist as cords or bands, very difficult to isolate. Very often they are shortened, and if not sacrificed during the breaking up of the ankylosis, they limit the separation of the surfaces. Many authors, notably Ogilvy and Ceballos, recommend preserving them. Others, considering that they oppose thorough exploration, particularly of the popliteal space, resect them more or less completely, if not entirely. Knowing the importance of these ligaments as regards stability of the joint, one seems caught in a dilemma: either the ligaments must be sacrificed to make a complete exposure and to obviate the possibility of re-ankylosis with the risk that lateral mobility be taken; or, in order to insure stability, the ligaments may be preserved at any price, with the danger that condylar bony bridges or fibrous masses remaining in the popliteal space may induce shortening and favor re-ankylosis. Payr chooses a medium course; he divides the ligaments after freeing them from all cicatricial tissue. The anterior half is detached from the tibia; the posterior from the femur. Both are then turned toward their insertion and detached from the adjacent meniscus.

I believe that it is not best to lay down any rule, but to conserve the ligaments whenever possible. If necessary, however, one should not hesitate to sacrifice them in order to get a good exposure, particularly as the concave and convex wedge-shaped modelling of the tibia and femur will practically insure stability. If the lateral approach is used, the lateral ligaments may undoubtedly interfere with adequate exposure, but with the U incision which I use, as do several other surgeons, they can usually be entirely preserved, and sufficient bone removed to allow free motion and adequate space to receive the graft implantation.

Modelling the osseous surfaces. This is a very important stage of the operation. Most authors recommend imitating the normal joint contour so far as possible, at once simplifying and exaggerating it, and also taking care that the transverse diameter is not made too short, as this will interfere with stability. Payr makes a convex-concave modeling 1 centimeter deep in the center, and from 2 to 2.5 centimeters in front and in back. That is to say, the convex inferior extremity of the femur will have a smaller radius than the concave superior extremity of the tibia. He also hollows out a deep groove for the patella, so that its shoulder impinging on the edges of this assures lateral stability of the joint.

I largely ignore the normal contour, and use the convex and concave wide V-shaped modelling already described, which has afforded satisfactory mobility and lateral stability in every case.

Those who attempt to approximate the contour of the normal joint use curved instruments; but for the wedge-shaped modelling the ordinary broad osteotome is used. Inas-

much as this technique works along straight lines rather than complicated curved ones, it is simpler to execute.

Various methods for securing lateral stability are suggested in the literature: preservation of the maximum transverse diameter of the epiphyses; painstaking care to insure a perfect fit of the articular surfaces. If it is remembered that in the normal knee, congruence between the bony surfaces does not exist but is effected only by the fibrocartilaginous menisces and that these have been destroyed or absorbed by the ankylosis or extirpated by the surgeon, we readily realize that it is necessary to establish between the bony surfaces themselves a most perfect fit. If an attempt to imitate the normal contour is made, the femoral condyle and the corresponding tibial surface should be modelled with the same gouge to assure a similar curve (Putti's method). One tibial surface may be separated from the other by an anteroposterior ridge, opposite which a deep groove is hollowed out between the condyles. To facilitate gliding movements in the nearthrosis, it has been suggested that the anteroposterior diameter of the condyles be diminished and their posterior projection shortened, particularly the condyles of the femur, which might form bone block to flexion.

Whether the author's wide V-shaped modelling or the more complicated attempt to imitate the normal is used, accuracy of fit, and wide diameters are essential to success. Arthroplasty is by no means an easy operation, and should be attempted only by those skilled in bone surgery.

The patella, frequently hypertrophied and often to enormous proportions, must be reduced, sometimes to one half its size. Its posterior surface is conformed like a donkey's back. Cuneo believes that reduction in the size of the patella is a means of getting a certain laxity of the patella-quadricipital apparatus.

The material for interposition. The evolution of the material used for interposition is interesting—from the early use of foreign bodies to the present introduction of organic tissue, the most favored being free autogenous fascia lata and fat grafts. The inadvisability of using foreign bodies was discovered when the technique of arthroplasties in other joints was being developed. A variety of substances such as wood, gold, aluminum, iodoform gauze, paraffin, gummed taffeta, celluloid, silver, rubber and batiste had been employed. The harder materials became fragmented or displaced, the pliable ones wrinkled and folded, and all were a frequent source of infection.

Then Murphy introduced the use of the pedicled flap of fascia and fat, and from this has gradually come the free fascia and fat flap taken from the thigh, either of the same or the opposite leg. In arthroplasty of the knee, the pedicled graft is many times not favorable material in that it may contain some scar tissue, or some of the old inflammatory process. Also the pedicle produces unfavorable conditions where it comes through the periphery of the joint. MacAusland recommends taking the graft from the opposite leg, and I believe that the point is well taken in that it eliminates trauma to the soft tissues above the knee, the importance of which in function has already been emphasized.

Baer uses the submucosa of the pig's bladder, specially prepared, and known as Baer's membrane. Whereas he has reported good results from this method in fibrous ankylosis, they are not good for bony ankylosis. Other surgeons who have tried the method report many failures.

Allison and Brooks experimented with Cargyle's membrane, free fascia from the fascia lata, pedunculated fascia flaps, chromicized pig's bladder (Baer), and fascia impregnated with silver, to determine the possibility of the interposed substance healing in, the length of time it may persist, the amount of reaction it produces, and its efficiency as a factor in the restoration of an anatomical articulation. It was found that Cargyle's membrane persisted between the opposed joint surfaces only for a few days, and did not prevent the adhesion of the opposed joint surfaces. Chromicized pig's bladder persisted for a longer time, but the reaction of the surrounding tissues was of such intensity that even at the time the membrane was disintegrating there were adhesions between the granulating surfaces.

Allison and Brooks recommend the use of silver impregnated fascia, since they found that this prevented the union of the denuded joint surfaces better than did free fascia, and did not cause any "marked local reaction." But silver is a foreign body and will stimulate tissue reaction. Nature's effort either to encapsulate it or to throw it off means overproduction of tissue, which is exactly what is not desired. In arthroplasty there should be the least possible amount of tissue reaction. The inclusion of fat with the fascia, certainly the living autogenous fascia and fat graft, unimpregnated, stimulates less reaction than anything else possibly could; this is a fundamental.

Certain essentials must be met by the material of interposition, if the arthroplasty is to be satisfactory: (1) it must be resistant to puncture; (2) if possible, it should be of semi-fluid consistency and sufficiently thick at certain points to fill all the crevices in the new formed joint; (3) it must be pliable, so that it will adapt itself to the contours of the joint; (4) it must set up a minimum of tissue reaction, since such reaction is likely to develop into adhesions or excessive exudate with the possibility of establishing a sinus outward; (5) it should remain unabsorbed for 30 to 40 days in order to limit osteogenesis; and (6) it must be sterile.

In meeting these requirements the autogenous fascia and fat graft stands out in a class by itself. The first two requirements are especially fulfilled by the combination of fascia lata and fat in that the dense, tough fascia lata resists puncture or penetration from bone pressure immediately following operation when the patient's muscles go into involuntary spasm, and also later during postoperative physiotherapy. The fat, being semi-fluid, answers the second requirement, as fascia lata alone cannot do. It is for this reason that I firmly believe that fat should be included in the graft.

Once the graft is in place, it is attached to the periosteum and to the adjacent structures by a continuous suture of No. 1 chromic catgut.

Closure. The closure of the joint should be meticulous. Care should be taken to leave the skin flap overlying interior work as thick as possible, continuous suture of No. 1 chromic catgut being used to close the subcutaneous tissues and continuous suture of No. 1 plain catgut for the skin, the object being to get immediate union and a sufficient thickness of tissue at the line of suture so that it will not break down following the operation. The tourniquet should be left on until the plaster cast has been applied from below up to it. This method of guarding against the formation of hæmatomata has already been discussed under "Author's technique."

Postoperative traction, weight-bearing and physiotherapy. Continuous traction on the new joint, and early voluntary movements are the essentials of after-treatment. As has already been stated, the traction is continued for at least 1½ months after the plaster is removed, and is maintained at nights after the patient begins to walk with crutches, but without weight-bearing. Weight-bearing is not permitted until at least 2 months after the operation.

The first difficulty which the physiotherapist has to overcome is fear on the part of the patient. The parts involved in the postoperative treatment are so extensive and the muscles so powerful that if these are in a state of spasm, the physiotherapist can make no progress. Obviously, every particle of fear must be allayed in order to relieve this spasm. Since the absolute confidence of the patient is the first step, gentleness must be used at first, but not too long, for unless rapid progress is made adhesions may develop and seriously retard, if not impair, the end-result. For that reason consistent work co-ordinating the mental with the physical should be carried on *daily*, for the first 4 weeks at least. Patients are sent home from these treatments with the feeling that use is not going to produce pain, but with instructions to give the joint perfect rest between treatments at first; to use hot applications, or sit in a hot tub soon after they get home. A little later they are taught how to do supplementary massage at home between treatments; then to hang the leg over the edge of the bed, and finally to use it, but not to the extent of producing pain.

SECONDARY OPERATIONS

If at the end of 3 to 6 months lateral mobility persists, Hey Groves recommends a second operation to reinforce lateral ligaments. This has not been found necessary with the author's technique, as in every case the joint has had most satisfactory lateral stability. But I have in several cases done secondary operations to sever restricting bands of fascia or scar tissue lateral to or above the patella which were limiting mobility, and the results have been excellent (Cases 2, 3, and 7).

These operations have varied in degree from a short incision and the severance of a small band or two of fascia or connective tissue to an extensive operation where even the new-formed joint has been unintentionally entered, and extensive soft parts severed.

We believe that this is a rather radical step that has not been practiced by other men, and personally I feel very enthusiastic about secondary operations to overcome tissue contractures interfering with motion. Case 2 (M.K.) is a striking example of what may be accomplished by secondary operation.

PLANNING ARTHRODESIS WITH VIEW TO FUTURE ARTHROPLASTY

Arthroplastic operations on the knee are becoming so satisfactory and the prognosis so favorable that one should certainly plan arthrodeses so that a future arthroplasty for mobility may be done under as favorable conditions as possible. For whatever cause an arthrodesis may be undertaken, it is important that the patella be left *in situ* in the quadriceps tendon because of the possibility of future arthroplasty.

Roentgenograms (Figs. 3 and 4) are shown of a typical case, illustrating the author's method of arthrodesis which is so planned as to establish the best condition for a future arthroplasty. Case 3 (E.F.) is a striking example of the wisdom of such a procedure, as the patient returned several years later with an urgent request for arthroplasty.

EVOLUTION OF NEARTHROSES

If it is true that a knee which at the end of 3 months has a mobility of 30 degrees will go on increasing the degree of excursion: it is certain that an excised capsule re-forms, and with it ligamentous cords re-form at useful points, it must be emphasized that all these processes progress extremely slowly. The nearthrosis is formed in the midst of surrounding tissues, just as the normal joint is formed in the mesenchyma of the embryo. If this genesis is slow in embryonic tissues, it is even slower in the completely evoluted tissues of the adult. Sudhoff had the opportunity to examine an elbow operated on 2 years before by Payr. He found histological phenomena showing that the articular tissues had not yet reached a stable, definite structure.

Pain does not usually persist after the first series of postoperative treatment. Soon, the epiphyses, correctly modelled, become painless.

The motor muscles gradually regain their ability to contract, even if they have been inactive for years. The reflexes re-appear. The different types of sensation—superficial and deep, baræsthesia, and sensation of position—are at length re-established as in a normal knee.

The nearthroses possess still another characteristic: once established—they are never the seat of effusion or of swelling. They seem to be resistant to all hæmatogenous arthritic processes. One of Payr's patients, a cavalry officer of the late war, fell from an aeroplane and his leg was immobilized for several months for an infected fracture of the femur on the side operated upon, yet the arthroplastic knee retained all its mobility.

The artificial joint created by the surgeon to relieve ankylosis is by no means a normal joint. It suffices that there is a joint which functions well.

RADIOGRAPHIC APPEARANCE

From the point of view of radiography, a knee which has been mobilized by arthroplasty for some time has a strong resemblance to chronic arthritis; the surfaces are not exactly plane, nor is the interline exactly linear. Free bony formations are frequently observed in the cavity. However, proliferative phenomena are not always lacking. Their appearance, as in a case of Mauclaire in which

osteophytes arose on the borders of the interline, determined re-ankylosis.

METROTHERAPY

During the postoperative treatment, it is often encouraging to the patient to let him observe the progress of function by means of metrotherapy apparatus, described by Gilliland and the author in 1920. Metrotherapy is a means of demonstrating to the patient just what effect treatment is producing. By means of accurate measurements of the amplitude, strength, and rapidity of voluntary movement of the impaired joint, the patient is shown the nature and the rate of his recovery. One of its greatest values lies in its psychologic effect on the man in interesting him in the progress of his own case. Even a small gain is most encouraging, and the patient is urged to try to beat his former records. These factors induce a maximum of voluntary effort and create a healthy interest in the mind of the patient.

SUMMARY

The prognosis for arthroplasty of the knee to relieve bony ankylosis has distinctly improved, owing to refinements of technique and a better understanding of the indications and selection of cases. The author presents certain original features, notably a wedge-shaped modelling of the joint which eliminates the danger of lateral stability and yet affords adequate mobility. Tuberculosis is not necessarily a contra-indication if the infection has been quiescent for a number of years. Such cases should be approached with conservatism, but not with pessimism, and careful X-ray studies are helpful in making the final decision. In arthroplasty, the steps following operation are almost as important as the surgery. Without them, and without the full co-operation of the patient, a perfect surgical operation may be followed by a functional failure. Ten cases which were operated on by the author with good functional result are reported.

Arthroplasty of the knee has, as yet, no standard technique. It is still an open chapter in joint surgery, and one which offers much promise.

Although the prognosis has definitely improved, the operation is by no means an easy one and should be attempted only by those skilled in bone-plastic surgery, and thoroughly familiar with the principles governing after-care.

AUTHOR'S CASES

CASE 1. Mr. R. E., aged 15 years. The patient had a double mastoid with very virulent streptococcus infection, and dissection was made even as far forward as under the muscle planes of his face on one side. This was followed by a metastatic infection in the knee joint of a very severe suppurative type. Repeated aspirations were carried on, to no avail. In fact the septic process increased in virulence. Extensive drainage laterally on both sides was instituted, but still without control of the infection.

An uncle was immunized with vaccines from the cultures made from the patient's knee, and the patient was transfused from this uncle on two occasions with a very satisfactory result. The suppuration of the knee gradually subsided and finally healed; but it left the joint completely ankylosed in extension, with bony union of tibia to femur and femur to patella.

Arthroplasty, by means of the technique already described, was performed July 12, 1922. Dressings were removed August 30. September 3 the wound was entirely healed and the patient had 15 degrees of active flexion. X-ray pictures showed a satisfactory new-formed joint. Weights at night were continued, and no weight bearing permitted, but massage and graded exercises begun. October 21, motion was still increasing, and after a forcible manipulation under anæsthesia to break and sever restricting bands, the progress was uneventful.

At present there is 85 degrees of active flexion. Function is most satisfactory as shown by the fact that the patient has recently won a swimming race, and enjoys other athletic pursuits.

CASE 2. Miss E. F., 17 years of age. At 17 months, the patient fell from her chair, and the right knee became stiff following this accident. At the age of 12, she was brought to the author because of pain and stiffness in this knee, which had previously been treated elsewhere by plaster cast and braces.

X-ray examination revealed a tuberculous process with extensive destruction of the joint. Arthrodesis was performed by the author in October, 1920, with the knee in 10 to 15 degrees of flexion.

Following this operation, the patient and her parents made repeated and persistent requests for an operation to produce mobility, until in May, 1924, much against his own desire and judgment, the author did an arthroplasty, and applied traction as described under technique. Except for a slight discharge from superficial structures, the recovery was uneventful and massage and exercises were

begun, traction being continued until 2 months after operation. In the latter part of August, the patient had slight motion, and this consistently increased until in December the result was good, except for some limitation of motion which seemed to be due to adhesions.

In February, 1925, the knee was manipulated under gas to break up adhesions around the patella; and this manipulation was repeated in May. Exercises and massage were continued until the excellent result shown in Figures 9, 10, and 11 was obtained. From the beginning there had been no lateral instability.

In September, 1927, the patient who had had 80 degrees of active flexion for some time, happened to meet another of my patients who had a slightly superior result, and she requested a secondary operation. As she expressed it, she felt some restriction at the inner aspect of the joint which she was not conscious of on the outer aspect; and believed if this restriction could be overcome, she would have a "perfect result."

This secondary operation was done September 19, 1927, and consisted of parallel skin incisions on either side of the quadriceps tendon just above the patella, and severance of all soft structures which were restricting flexion. The new-formed joint was unintentionally entered at the outer incision, but by dissecting up the new-formed capsule or joint membrane, it was possible to secure a favorable closure. Fat tissue was dissected away from beneath the skin on the outer side of the outer incision and on the inside of the inner incision, and drawn into the clefts made while the leg was in extreme flexion. The skin was closed in the usual manner.

The knee was put up in flexion of 110 degrees and that position maintained in plaster for one week, after which the cast was removed and 15 pounds of traction applied to bring the leg into full extension again. Massage and exercises were begun at this time, but traction at night continued. Later the patient was allowed to walk with crutches without weight-bearing. At the present writing the patient is bearing weight, walking without cane or crutch.

Case 3. Miss M. K., 18 years of age. Patient had bony ankylosis of the right knee following a pronounced osteomyelitis of 3 years' duration. The wound healed for 2 months when patient consulted author in December, 1925. The knee was fixed in 10 degrees of flexion. Arthroplasty was performed December 15, 1925, and traction applied. Recovery was uneventful. Massage and exercises were begun February 8, 1926. March 19, 1926, the knee was manipulated under gas to a right angle of motion. This was repeated in August.

Although mobility constantly increased, there still seemed to be constricting bands which prevented the patient from getting complete mobility. Therefore on January 19, 1927, a secondary open operation was performed, and all soft parts and fascia lateral to the quadriceps tendon which were restricting flexion were severed. The knee was put up in plaster in 120 degrees of flexion for one week. The plaster was then removed and 10 pounds of traction was applied to straighten the limb. Later massage and exercises were begun, and gradually weight-bearing permitted.

In November, 1927, the result was excellent; active extension was practically normal, there was active flexion of 95 degrees, and no lateral instability (Figures 12 to 16).

Case 4. Mrs. D. L., 33 years of age. In July, 1920, after recovery from typhoid, the patient fell and injured her right knee. A cast was applied for 3½ months, and when the cast was removed, there was complete bony ankylosis. The patient insisted on arthroplasty, which was performed March 20, 1921. When last seen, the progress was very satisfactory, but we are unable to determine the ultimate result as a follow-up letter was returned.

Case 5. Mr. D. H., 43 years of age. This is a case of arthroplasty. The right knee was injured in an automobile accident, and was put up in a cast for 4 weeks. Eight weeks after the accident, open drainage of the joint was instituted and a cast applied in a right angle of flexion, for 12 days. The patient consulted the author one year after the accident on account of bony ankylosis in full extension. Arthroplasty was performed in February, 1925.

A letter from the patient October 31, 1927 reads: "I have more than a right angle of flexion, and the extension is about normal. There is nothing in my walk to indicate there ever was anything wrong. I ride horseback, play tennis, and in every other way lead a normal physical life."

Case 6. Mr. J. W. C., 36 years of age, was injured in an automobile accident and subsequently had a pyæmic infection of the knee joint. Three open operations had been performed, resulting in complete bony ankylosis in 15 to 20 degrees of flexion.

The patient consulted the author August 24, 1926, and arthroplasty was performed September 30. The end-result was satisfactory: active extension was practically normal, active flexion to 85 degrees, and there was no lateral instability.

Case 7. Miss A. M., 23 years of age. An acute osteomyelitis of the left tibia with metastatic infection to hip, knee, and ankle, lead to complete bony ankylosis of the hip and knee and partial or fibrous ankylosis of the ankle. The knee was ankylosed in from 50 to 20 degrees flexion.

When the patient consulted the author, the ankylosis had existed for 3 years. Arthroplasty was performed February 11, 1926, and traction was immediately applied. Postoperative treatment as described was carried out. Manipulation under gas was carried out April 17, 1926 to increase the range of motion. June 7, 1926, a secondary operation was performed to sever a band of fascia which was restricting motion. The patient now has 80 degrees of active flexion, normal active extension, and lateral stability.

This case, as well as Cases 1 and 3, illustrates the possibilities of secondary operation.

CASE 8. Miss H. S., 24 years of age. The left knee was badly cut and bruised in an automobile accident, with subsequent suppurative arthritis, which resulted in complete bony ankylosis in 20 degrees of flexion. The patient had been strongly advised against arthroplasty by a well known orthopedic surgeon. She consulted the author 15 months after the accident, and as there seemed to be no contra-indications, and the patient fully realized the seriousness of the operation, and desired it for both social and professional reasons, arthroplasty was performed at once, September 8, 1927. At the time of writing, December 1, there is 75 degrees of active flexion and motion is still increasing very satisfactorily.

CASE 9. Mr. A. K., aged 23 years. Following an attack of gonorrhœa 4 years previously, complete bony ankylosis of the patella to the condyles of the femur developed. The knee had been treated with baking and massage. At the time of the author's examination, the knee was fixed in 10 to 15 degrees of flexion, and was painful on excessive weight-bearing. In January, 1924, arthroplasty of the patella was performed. The operation did not follow the technique described for the other cases, but consisted of the chiselling up of the patella from the condyles in the usual manner, and the implantation of a graft of fascia lata and fat. The end-result was good.

CASE 10. Mrs. C. L., 48 years of age. An infection following an injury in an automobile accident led to complete bony ankylosis of the right knee, in 15 degrees of flexion. Open drainage had been instituted 9 days after the accident. The patient consulted the author one year after the accident, and arthroplasty was performed November 6, 1926, by the technique described. The result in this case is not as striking as in the others reported, but the patient gets about satisfactorily. She has 60 degrees of active flexion, adequate active extension, and no lateral instability.

REFERENCES[1]

1. ALBEE, F. H., and GILLILAND, A. M. Metrotherapy. or the measure of voluntary movement. J. Am. M. Ass., 1920, lxxv, 983-6.
2. ALLISON and BROOKS. Surg., Gynec. & Obst., 1923, xvii, 645; Am. J. Orthop. Surg., 1918, xvi, 83–93.
3. BAER. Tr. South. Surg. Ass., 1916, xxix, 126; Am. J. Orthop. Surg., 1918, xvi, 170.
4. CAMPBELL. Am. J. Orthop. Surg., 1921, iii, 430; Ann. Surg., 1922, Nov., 615; Ann. Surg., 1924, lxxx.
5. CHEVALIER, C. H. L'arthroplastie du genou. Paris: Masson et Cie, 1926.
6. HENDERSON, M. S. Am. J. Orthop. Surg., 1918, xvi, 30–33; Minnesota Med., February, 1925; Surg. J., March, 1926; also personal communication.
7. JONES and LOVETT. Orthopedic Surgery. New York: William Wood Company, 1923, p. 105–109.
8. KIRSCHNER. Verhandl. d. deutsch. Gesellsch. f. orthop. Chir., X Kong. Berl., 1910, 222.
9. MACAUSLAND, W. R. Mobilization of ankylosed joints. Surg., Gynec. & Obst., 1923, xxxvii, 255.
10. MURPHY, J. B. J. Am. M. Ass., May 20, 1905; ibid, June, 1912; Ann. Surg., 1913, lvii, May, 1913; Murphy's Clin., October, 1915; Surg. Clin., 1912, 1914, 1916; Murphy Clin., 1918.
11. PAYR. Deutsche Ztschr. f. Chir., 1914, cxxix, 341; Arch. f. klin. Chir., Berl., 1914, cvi, 235.
12. PUTTI, J. Orthop. Surg., 1912, iii, 421; Sixth Congress of Intern. Soc. Surg., London, July, 1923, vi; Impremerie médicale et Scientifique, Bruxelles., Am. J. Orthop., Surg., 1921, iii.

[1]For exhaustive bibliographies, see Chevalier and MacAusland.

AUTOTRANSPLANTATION OF ENDOMETRIUM IN THE EYE OF RABBITS

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AUTOTRANSPLANTATION of endometrium in the ordinary laboratory animals lends itself to many interesting and instructive problems as applied to the human female. Interpretation of some of the results are, however, more difficult because of differences in the cyclic changes of œstrus and menstruation as well as in the structure of the endometrium itself. Many investigations have shown the comparative ease with which endometrial tissue will "take" when transplanted to distant points in the abdominal cavity.

Following the advancement of the now widely accepted transplantation theory of Sampson (10), his co-worker Jacobson (6) reported the production of epithelium-lined cysts by autotransplantation of bits of endometrium into different places in the pelvis and abdominal cavity of rabbits. Later Jacobson (7) repeated this work using monkeys. In this series the survival of the implant was not quite so constant, but the bleeding which occurred in at least one of these endometrium-like cysts seemed to be very much like that occurring in similar growths in women.

Several years before Jacobson's work, Stilling (11), also working with rabbits, was able consistently to implant pieces of vagina, uterus, and endometrium into the spleen and produce cysts of various sizes which were lined with ciliated columnar epithelium. These cysts contained secretion under tension, yet the epithelium often piled up in papillary outgrowths. The wall of these cysts would also regenerate, after a piece had been removed for section.

Hesselberg, Kerwin, and Loeb (5) transplanted kidney, thyroid, uterus, and endometrium in guinea pigs. They found that, about 3 days after implantation, regeneration of the cells, which had become necrotic since removal, began, and at 5 days a firm attachment to the host had occurred. This attached tissue formed cysts with a retention of the uterine epithelium but little of the uterine musculature. Mitotic figures were much more common in the uterine epithelial cells than in the kidney and thyroid tissue, indicating that the epithelium of the endometrium was more responsive to proliferative stimuli.

The experimental work of Bykow (1), in which he transplanted the entire uterus of young dogs to the omentum, would also indicate that the endometrium has greater tendencies of proliferation than the uterine muscle or its supporting connective tissue. In the 4 animals which he used in this work, the transplanted uterus showed a development into the adult type of cell, but only the endometrium exposed by amputation revealed a tendency to active proliferation.

O'Keefe and Crossen (9) report 5 successful implantations in a series of 10 dogs. All of these implants were transferred to the region of the appendix, except one, which was introduced into the ovary. The most characteristic finding in this group seemed to be the dense adhesions formed about the implantation site. This is also a constant finding in the ectopic endometrial growths in women.

Much discussion has arisen concerning the advisability of castration in the treatment of advanced human endometriosis. The work of Katz and Szenes (8) would indicate that the proliferation of epithelium and cyst formation, at least in these transplanted bits of endometrium, is dependent on ovarian function. It occurred to us that further observations might be made, if we could implant pieces of endometrium in a location where the changes from day to day could be observed. The anterior chamber of the eye seemed to fill most of these requirements, viz., visibility, circulation, fixation, and the ease with which the implant could be recovered for microscopic study. Not only is the vascularization of the eye sufficient, but just as soon as the tissue is slipped beneath the

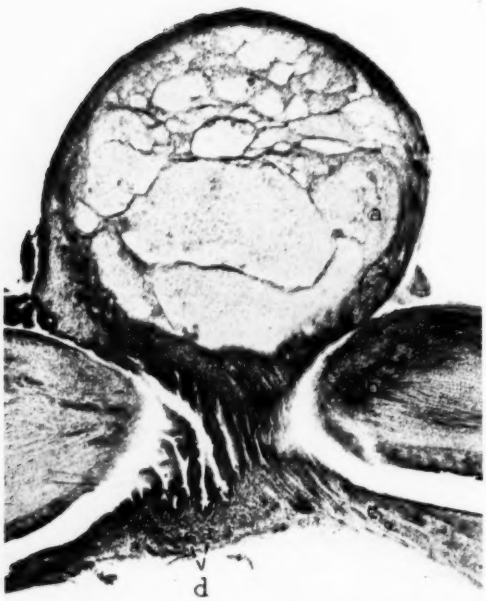

Fig. 1. Showing extrusion of the implant, *a*, through the separated ends of the cornea, *b*. The attachment of the implant to the iris, *c*, shows well formed uterine glands, *d*.

Fig. 2. The cystic spaces, *b*, are well shown lying on and in the substances of the iris.

cornea, it is bathed in a circulating fluid that should maintain vitality and promote growth.

METHOD

In this experiment 25 rabbits were used. Under ether anæsthesia, the abdomen was opened by a midline incision. Small portions or all of the uteri were removed, placed in warm normal salt solution, and as soon as possible small pieces were implanted in the anterior chamber of each eye. Small bits of testicular tissue were implanted in the eyes of 4 of these rabbits for a comparative check on growth and reaction. With a little practice we found that we could readily insert pieces up to the size of a split pea. After the abdomen was closed a small piece of tissue was implanted in the abdominal incision of each animal.

The eyes were first prepared by clipping the lid-hair short with ordinary finger nail scissors. A drop of mercurochrome dropped into each eye furnished enough fluid for the easy handling of the implant. With the eye fixed and slightly rotated, an incision was made through the cornea at the limbus, with an ordinary cataract knife. Sufficient fluid usually escaped so that the intra-ocular tension was decreased enough to allow the implant to be easily inserted into the anterior chamber on the end of a blunt eye spatula. In the beginning we closed the lids by a single interrupted suture for the first 48 hours, but later better results were obtained by leaving the eye open without any form of dressing.

RESULTS

No attempt will be made to describe the progress of growth or microscopic findings in the separate animals except those that showed unusual conditions. We shall try to give a composite picture of the course of growth, gross and microscopic pathology of this group of specimens, and the conclusions we draw from them.

A successful "take" was obtained in 44 of the 50 eyes. The eyes were either enucleated separately, or when the last one was to be

Fig. 3. The ciliated columnar epithelium, *a*, can be seen spreading outward over the anterior surface of the iris, *b*, and extending on to the posterior surface of the cornea, *c*.

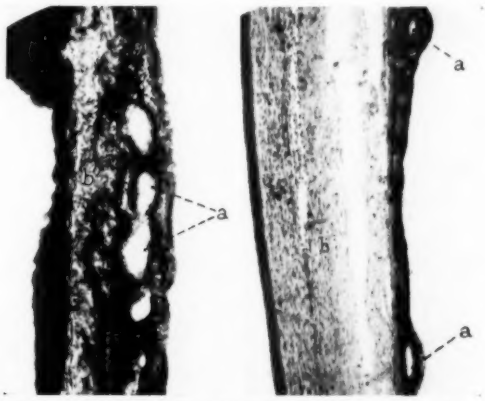

Fig. 4. (left) The invading glands, *a*, are shown here quite definitely deep in the stroma of the iris, *b*.

Fig. 5. Epithelial lined glands, *a*, in this section appear in the substance of the cornea, *b*.

removed, the animal was killed with ether, and an autopsy performed. The eyes were fixed in Zenker's solution and sectioned in celloidin. The time of removal varied from 2 to 14 months.

In from 12 to 24 hours after the tissue was implanted in the anterior chamber, the eye showed a marked reaction as from a foreign body. There was a profuse secretion. The conjunctiva was congested and photophobia seemed to be present. A marked congestion of all the vessels at the limbus took place. In about half the eyes the fluid of the anterior chamber became somewhat turbid. Usually this acute reaction had subsided by the sixth or eighth day. Definite dilated blood vessels could now be seen centering about and entering into the substance of the implant.

During the next 2 or 3 weeks there was a gradually increasing keratoconus and glaucoma in about 90 per cent of all the eyes containing uterine tissue. This keratoconus sometimes reached surprising proportions. In a few of the eyes the intra-ocular pressure became so pronounced that the cornea broke down at its apex, ulcerated, and the eye had to be enucleated to prevent infection. In one case (Fig. 1) the implant with the iris attached was forced through the break in the cornea.

During the next 4 weeks changes were noted which we were able to interpret only after some of the eyes had been sectioned. The most common finding was the appearance of cystic spaces varying from pinhead size to about 5 millimeters in diameter. The microscopic structure of these epithelium-lined cysts is well illustrated in Figure 2. These cystic collections did not seem to increase in size or cause any abnormal reaction.

Less frequently we noticed a patchy deepening of the pigmentation of the iris. These thickened, darkened areas spread from the base of the implant outward in irregular patterns. Microscopically, these areas seemed to correspond with the active layer of epithelial cells which had covered over the anterior surface of the iris from the pupil to the angle with the cornea (Fig. 3). This epithelium was directly continuous with, and similar to, that covering and contained in the glands of the transplant. In those portions nearest the implant, it was high columnar and ciliated. At the periphery, the cells were more often cuboidal. In many places, budding or bleb formation was present, as if cilia were being formed.

Many times this epithelium seemed to have a tendency toward the formation of glandular structures resembling the original endometrial glands. Most often this occurred on the anterior surface of the iris. In only a few

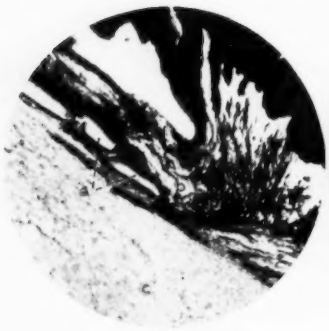

Fig. 6.

Fig. 7.

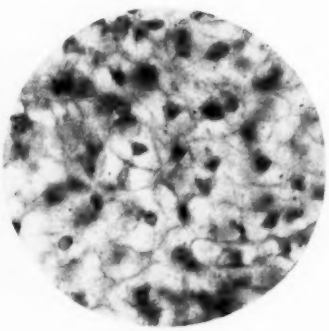

Fig. 8.

Fig. 6. Gland-like inclusions of columnar epithelium, *a*, appear here at the angle of the iris, *b*, with the cornea, *c*.

Fig. 7. The anterior chamber is almost filled here with typical uterine tissue. The dilated tortuous glands, *a*, and the decidua, *b*, resemble quite closely the decidua of pregnancy.

Fig. 8. High power of endometrial stroma in implant of the eye of pregnant rabbit.

instances did these gland-like structures appear to be invading the stroma of the iris (Figs. 2 and 4). That these were probably not invaginations of the epithelium following irregularities of the surface of the iris, seemed to be indicated by the beginning of the formation of like spaces in the smooth under surface of the cornea (Fig. 5). Quite frequently gland-like mechanisms were present in the angle of the anterior chamber (Fig. 6). However, these were most probably formed by the attachment of the iris to the under surface of the cornea.

Fischer (4) and Ebeling (3) have shown experimentally in tissue culture that epithelium has the ability to form a delicate continuous layer over the surface of artificial media. They were also able to demonstrate that epithelial cells have the property of assuming tubular arrangements which resemble glands.

In human endometriosis the question always confronts us as to the origin of the stroma which is found surrounding the islands of ectopic endometrial glands. It would seem that since the stroma of the endometrium is vital, embryonic connective tissue, its rate of growth or at least its proliferative tendencies would be greater than that of epithelial cells under the same conditions. In tissue culture Carrel (2) has shown that under given surroundings, fibroblasts proliferate much more rapidly and eventually will even stop the growth of epithelial cells when grown in mixed culture. We were not able to identify any proliferative tendency of the endometrial stroma or uterine musculature in any of these specimens, although relatively large amounts of both were contained in all of these implants. It certainly would not seem that the stromal cells are a response to the ectopic presence of misplaced epithelial cells, or that the stromal cells themselves have sufficient proliferative tendency to follow along with the outward extension of the epithelium.

In 2 of these rabbits that became pregnant subsequently to the implantation, we observed changes in the ectopic tissue which resemble those found in a section of the decidua vera (Figs. 7 and 8). There seems to be a definite swelling and œdema of the stromal cells. The glands are more tortuous, elongated and abundant.

The fact that the epithelium-lined cysts mentioned did not increase in size would indicate a lack of secretory activity on the part of the epithelium. On the other hand, the uniform increase in the intra-ocular pressure with the resultant keratoconus would suggest the possibility of secretory activity. Interference with equalization of pressure through the canal of Schlemm by means of the spreading epithelium may be the more simple explanation, and, if so, might offer material for study in the production of experimental glaucoma. Very definite microscopic evidence

Fig. 9.

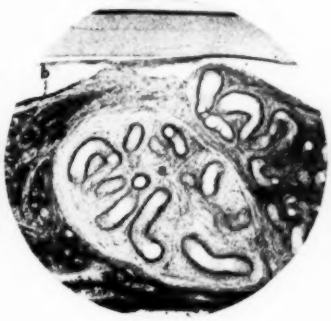

Fig. 10.

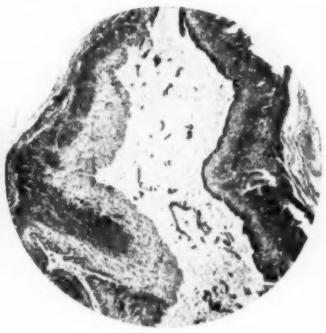

Fig. 11.

Fig. 9. Due to the necessity of cutting the eye sections rather thick it is difficult to demonstrate the secretory activity of the epithelium, *a*. Faint outlines of the secretion and blebs can be seen at *b*.

Fig. 10. Implant, *a*, is composed of testicular tissue which has undergone regressive changes. The peritoneal covering at *b* does not show any tendency to proliferate.

Fig. 11. Section taken from implant in anterior abdominal wall. Does not show any definite endometrial structure. Some of the cell débris seems to be of epithelial origin.

of secretory activity is present in the epithelium of the endometrial glands; in fact under high magnification, many of the glands showed stained coagulated secretion issuing from the tips of the epithelial cells (Fig. 9).

The eyes in which testicular tissue was implanted, showed the same acute primary reaction as did those containing uterine tissue. After this reaction had subsided, however, no further changes were observed. When the implant encroached upon the pupil, vision, of course, was decreased or lost. Increased intra-ocular pressure and epithelial proliferation or cyst formation did not occur, in spite of the fact that some of the peritoneal epithelium was included with the testicular tissue (Fig. 10).

Sections taken from the implanted area in the abdominal wall revealed a possible survival of tissue in only 2 animals. Cell necrosis in this area is so well advanced that identification of cell type is difficult, but it seems to be the epithelial cells that have survived (Fig. 11).

CONCLUSIONS

1. The epithelium of the endometrium in rabbits has a marked tendency to proliferate.

2. This proliferated epithelium tends to retain its secretory ability and reproduces gland-like spaces and cystic cavities.

3. The ability to invade other tissue is not so marked as its tendency to proliferate but seems to be quite definite.

4. Ectopic endometrial epithelium did not tend to produce a connective tissue reaction in these transplantations.

5. Endometrium transplanted to the eye of rabbits will undergo the same decidual reaction as takes place in pregnant uterus.

6. Transplanted endometrial stroma and uterine musculature remain viable for long periods of time without showing any tendency toward further growth.

7. Testicular or peritoneal epithelium did not show a similar ability to proliferate or invade.

8. The abdominal wall does not seem to favor the survival of implanted endometrial tissue in rabbits.

BIBLIOGRAPHY

1. Bykow, S. G. Monatsschr. f. Geburtsh. u. Gynaek., 1927, lxxvii, 186.
2. Carrel, A. Physiol. Rev., 1924, iv, No. 1.
3. Ebeling, A. H., and Fischer, A. J. Exper. M., 1922, xxxvi, 285.
4. Fischer, A. J. Exper. M., 1922, xxxv, 367.
5. Hesselberg, Kerwin, and Loeb. J. Med. Research, 1918, xxxviii.
6. Jacobson, V. C. Arch. Surg., 1922, v, 281.
7. Jacobson, V. C. Arch. Path. & Lab. Med., 1926, 1.
8. Katz, H., and Szenes, A. Ztschr. f. Geburtsh. u. Gynaek., 1926, xc, 74.
9. O'Keefe, C. D., and Crossen, R. J. J. Missouri St. Med. Ass., 1927, xxiv, 252.
10. Sampson. Am. J. Obst. & Gynec., 1922, iv.
11. Stilling, H. Beitr. z. path. Anat. u. z. allg. Path., 1910, xlvii, 499.

ADULT HUMAN ENDOMETRIUM IN TISSUE CULTURE[1]

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OUR knowledge of the functions and inter-relation of the female genital organs has been gained largely by clinical observation and by the use of pathological and physiological methods of study. Practically all our ideas concerning the relation of the ovary to the menstrual cycle have been gathered by use of the older histological methods, together with seemingly logical deductions from animal experimentation. By these means a large number of generalizations have been made possible, but we are still much in doubt as to the actual mechanisms by which the cyclical changes are produced, such as we see going on in the endometrium, ovary, and other organs during the intermenstrual period.

Our ideas bearing upon the relation of the ovary to the changes which occur in the endometrium during the menstrual cycle are founded pretty largely upon the synchronous appearance of the graafian follicle followed by the corpus luteum and a seemingly consistent change in the endometrium, together with observations of what occurs in the absence of ovarian changes, absence of ovaries, or suppression of their activity. Accurate information concerning the details of these changes has been withheld principally for the reason that, thus far, no method has sufficed for the close inspection of the various tissues concerned during the change, and no method has allowed the isolation of the many complicating factors of importance. Realizing this, and casting about for a new method of approach, it was thought important to determine whether or not the tissue culture technique with its opportunities for observation and control could be applied to the problem.

Thus far the method of tissue culture has been confined almost entirely to the study of embryonic tissues because these are far more easily and satisfactorily grown. Adult tissues of any origin are more difficult of continuous cultivation than are those from young or embryonic organisms for the reason, apparently, that embryonic cells possess greater ability to cause synthesis of protoplasm from the various types of media that have thus far been developed. But despite this fact, it was hoped that if a method could be devised whereby adult human endometrial and ovarian cells could be cultured, the facilities would be at hand which would overcome, to a certain extent, the difficulties that have hindered the accumulation of more detailed and specific information in this field. It would be valuable, because the tissues could be watched continuously from hour to hour, through all their changes, and each experiment could be adequately controlled. It would also provide the possibility of varying the forces at work, or of altering them completely.

Such a technique has been devised and human endometrium has been grown successfully after many fruitless attempts, for as long as 20 days *in vitro*. Its principal features are identical with, or are modifications of, the technique which has been developed by Carrel (2, 3).

TECHNIQUE

The endometrial tissues were secured from the uterine cavity of uteri freshly received from the operating room. While still warm and sterile, the uterus was opened and a small portion of endometrium was removed and placed in warm, sterile Ringer's solution. At the same time blocks were also cut from the endometrium for microscopical preparations. These sections gave information concerning the stage of the menstrual cycle, and the presence or absence of infection.

The sterile endometrium was carefully washed in several changes of Ringer's solution to free it of all possible traces of blood. This step is quite important as was found by experience, for traces of blood serum are very inhibitory to the growth of adult cells. The tissue was cut into very small fragments. These were transplanted into a medium composed of two parts; one part was solid and formed from a fibrinogen suspension and

[1] Read before the Medical and Chirurgical Faculty of Maryland, April 27, 1927.

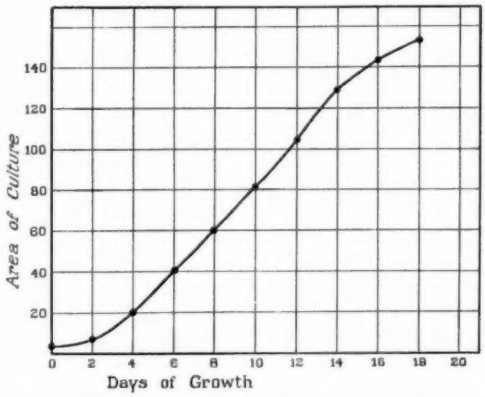

Fig. 1. The composite growth curve of 15 cultures of stroma cells of human endometrium. There is a latent period of 2 days in which little growth occurs. The rate of growth is approximately one half that of embryonic fibroblasts in the same media.

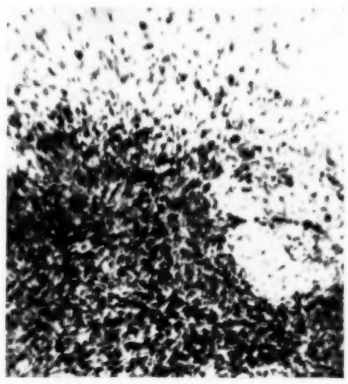

Fig. 2. The edge of a culture of endometrial stroma cells. The culture is 14 days old. This culture was grown in a medium in which corpus luteum extract was substituted for embryonic tissue extract.

dilute embryonic extract containing a trace of sodium linoleate to prevent digestion of the clot; the other part was fluid and was composed of tyrode solution. The fibrinogen suspension was introduced first, being diluted with an equal volume of tyrode solution, so that the whole volume was 1 cubic centimeter. Tyrode solution, 0.5 cubic centimeter, containing a trace of sodium linoleate, and 0.5 cubic centimeter of dilute embryonic extract were then added. The fragments of endometrium were then carefully placed in the medium, equidistant from one another, before coagulation took place. The medium was then allowed to solidify and 1 cubic centimeter of tyrode solution was added. Before the implantation of the tissue was done, the medium was carefully tested to determine the hydrogen ion concentration, and the necessary modification made. The hydrogen ion concentration was maintained at approximately 7.2. The fluid medium was changed every day and replaced by fresh tyrode solution. The use of fibrinogen suspension as the source of the clot was adopted when it was found that the small traces of serum remaining in the clots formed from plasma was inhibitory, even after repeated washings.

The rate of growth of the cultures was measured each 48 hours. They were placed in a projectoscope which cast a shadow of known magnification, the shadow was outlined, its area measured by means of a planimeter, and the area computed and charted. The areas were plotted from day to day, so that a growth curve for the various cultures was kept. In this way it was possible to ascertain with a good deal of accuracy the average rate of growth of the endometrial cells in the media used. This was found to be about half as fast as that of embryonic cells in the same media.

DESCRIPTION OF THE ENDOMETRIAL CULTURES

During the first 2 days following transplantation, the explant increased only slightly in size. The following 2 days, there was an increased rate of growth roughly twice that of the preceding period. Subsequently, the rate of growth remained about the same, there being an almost uniform increase in size. Accidents such as infection or liquefaction of the clot, of course, stopped growth or slowed it, and such cultures were discarded. Figure 1 is a composite chart of 15 cultures and demonstrates graphically the rate of growth of the tissue.

At various stages cultures were fixed, stained, and mounted for microscopic study. It was found that the growth occurred almost wholly from the stromal or connective tissue portions of the explant. The epithelial cells

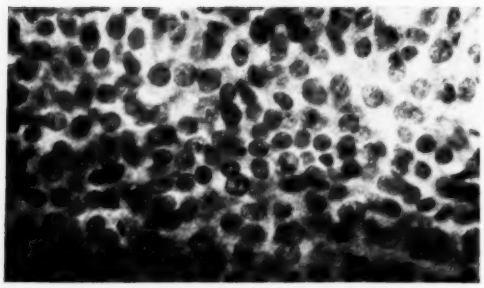

Fig. 3. A pure culture of endometrial epithelium, 11 days old. There is no tendency toward gland formation. Thus far differentiation into a glandular pattern has not occurred in any of the cultures.

apparently had such a long latent period that they were overgrown by the stroma cells. This gave an almost pure strain of connective-tissue cells on the periphery of the cultures, and by carefully sectioning a culture so as to obtain only the peripheral cells we were able to obtain pure strains of stroma cells. Figure 2 is a culture grown from such an explant. Figure 3 is a high power photomicrograph of an almost pure culture of epithelial cells obtained in a similar manner from a culture in which the stroma was scant and in which the epithelium survived and grew luxuriantly.

EXPERIMENT

Being possessed of a pure culture of stroma cells which was growing at a known rate of growth in a media of known composition, viz., serum free, fibrin clot, embryonic extract and tyrode solution, it seemed desirable to determine if possible what effect follicular fluid and an extract of corpus luteum cells would have on such a culture, if used to replace the embryonic extract.

Follicular fluid was obtained from unruptured graafian follicles. These were found in freshly removed human ovaries from the operating room.

In a similar manner corpora lutea were obtained and an extract of the cells made in a manner exactly similar to that used for the preparation of the embryo extract. That is, the corpora lutea were carefully dissected out of the ovary, cut into small fragments and washed in numerous changes of sterile Ringer's solution. The fragments were placed in a sterile Latapie apparatus, crushed, mixed with an equal volume of Ringer's solution and frozen and thawed twice to rupture the cells. Again an equal volume of Ringer's solution was added, the mixture placed in centrifuge tubes, centrifugalized for 10 minutes and the supernatant fluid decanted. This constituted the corpus luteum extract used in the experiments.

An experiment consisted of three groups of 15 cultures each. All three groups had similar media with the exception that A had embryonic tissue juice, B had follicular fluid replacing the embryonic tissue juice, and C had the corpus luteum extract replacing the embryonic extract, all in similar volume.

The cultures in B group survived 6 or 8 days with slight cell migration, but no real growth. Repeated experiments with greater volumes of the follicular fluid gave the same result.

The result was quite different in group C, in which the corpus luteum extract was used in place of the embryonic extract. Here there was a most luxuriant and rapid growth of the cells, equaling and in some instances exceeding the rate of growth in the cultures containing the embryonic extract. Controls consisting of cultures in which ovarian stroma cell extract was used were not made. This was not considered necessary in the light of Drew's work (5), in which he found that adult cells did not grow in the absence of embryonic extract or in the absence of autolytic products which he thought were formed in the explant itself after several days of incubation. Obviously, these experiments should be repeated with the ovarian stroma cells as controls to eliminate a possible source of misconception.

Figure 5 gives in the form of a graph the relative rates of growth in the three types of cultures. It will be seen at once that, in this series of experiments, 15 cultures to the group, 45 to the experiment, in the corpus luteum extract as made, there are substances analogous to those contained in embryonic extract. That is, there are substances present which enable the cells to metabolize some portion of the culture media into protoplasm, and to reproduce themselves. That these are not the autolytic substances described by Drew

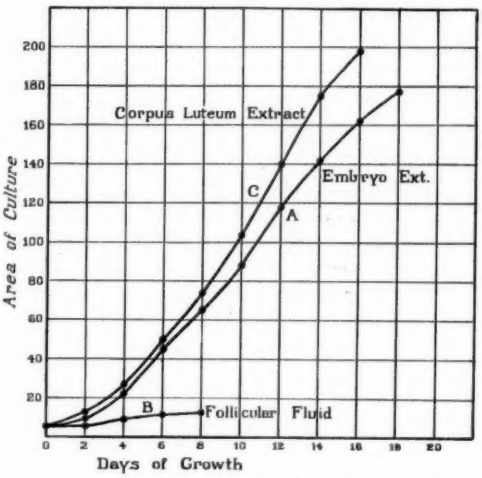

Fig. 5. A graph representing the composite growth curves of 3 series of cultures. Each series consisted of 15 cultures. They were similar except that *A*, contained embryonic tissue extract; *B*, contained follicular fluid; *C*, contained corpus luteum extract.

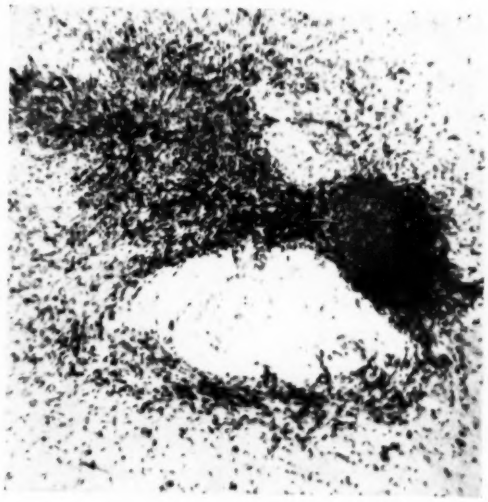

Fig. 4. An 18 day culture of stroma cells, grown with corpus luteum extract. The dark group of cells (right) represents the original explant. There was liquefaction of the clot, hence the irregular outlines of the culture.

seems certain, as the extract was used fresh and was kept in an ice box. On the other hand, it seems to be a much more stable substance than that contained in embryonic extract as temperatures up to 65 degrees C. for 15 minutes did not affect its potency to any appreciable extent.

DISCUSSION

The question at once arises as to the nature of the substances present in the corpus luteum extract, is it similar to that contained in embryonic extract, and is it the same substance which causes the cyclical changes in endometrium in the woman? The latter cannot be answered at present. The former probably can be settled by further study.

Carrel and Baker (1), in a very brilliant series of experiments, have demonstrated that fibroblasts in pure culture obtain the nitrogen from which they build protoplasm, from proteoses, and other primary derivatives of proteins. By splitting the protein molecule to various degrees they have obtained substances, proteoses, which are assimilated by the cells and metabolized to form protoplasm. They were able to produce this substance from a variety of sources. They replaced the embryonic extract by solutions of proteoses, in their tissue cultures, and secured cellular response in the form of growth activity very closely paralleling that of their embryonic extract controls.

In view of their work, which was published after this study was well advanced, it is obviously necessary to repeat the corpus luteum extract experiments with extracts which have had careful nitrogen determinations, to discover the degree to which the protein molecules in them may have been split, before any definite conclusions can be drawn from this work. The work is presented at this time as a demonstration that the method is practical for the object in view, and that in the near future physiological problems may be attacked by this method of study with the possibility that valuable information may be gleaned by its use. It is also a demonstration of the practicability of the use of adult tissues in this connection.

REFERENCES

1. Carrel and Baker. J. Exp. Med., xliv, 503.
2. Carrel. J. Exp. Med., xxxviii, 407.
3. Idem. Physiological Reviews, vol. iv, 1.
4. Cron and Gey. Am. J. Obst. & Gynec., xiii, 645.
5. Drew. Lancet, cciv, 833.

CHONDRODYSPLASIA

By MATHER CLEVELAND, M.D., New York
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MY interest in chondrodysplasia was aroused by the presentation of a case by Cole (8) in 1926, which was almost the exact counterpart of a case we have had under observation at the New York Orthopædic Dispensary.

The condition is generally considered to have been first described by Ollier (19) in 1899 as irregular growths of cartilage localized near the epiphyses of the long bones of one side of the body with resulting skeletal deformity. These cartilaginous masses adjacent to the epiphyses undergo delayed ossification, which behavior differentiates them from multiple chondromata, which never ossify. Ollier considered the condition to be quite distinct from achondroplasia with its more complete arrest of development, but in his opinion it is not unlike rachitis, which results in overgrowth of cartilage at the epiphyses, with subsequent ossification. He noted lesions in the phalanges of the fingers with resulting soft consistency, allowing the phalanx to be pierced readily. Chondrodysplasia tends to heal spontaneously by replacement of cartilage with bone.

The disease, described by Ollier, was made the subject of a thesis by his pupil Molin (18) in 1900, who described 3 cases, 2 of Ollier's and 1 of Nové-Josserand and Destot's. He stated that the identity of dyschondroplasia and osteogenic exostosis needed further study. The salient features of the type of dyschondroplasia which he described may be stated as follows: It is an osseous dystrophy affecting the long bones of the extremities and the metacarpophalangeal skeleton, with partial arrest of development and curvature of the long bones resulting. The diagnosis can be made by roentgenography. Its etiology is unknown and there are no microscopic or macroscopic observations on the disease. Molin's observations regarding the confusion[1] existing between chondrodysplasia or dyschondroplasia and multiple cartilaginous exostosis were timely, and, as a matter of fact, the confusion of terms and conditions still persists.

Ehrenfried (10) reported 600 cases of hereditary deforming cartilaginous tumors under the title of "Hereditary Deforming Chondrodysplasia." Among this large group, less than 1 per cent showed marked asymmetry. Ashhurst (1), under the same title, reported 11 cases that he had observed. Among others reporting cases of hereditary deforming cartilaginous tumors are Percy (21), Renfrew White (23), Campbell (6), Ord (20), and Lewin (16). The latter recently recorded 6 cases and used the name suggested to Keith and used by him, diaphyseal aclasis.[2] Keith (14) considers Ollier's type of chondrodysplasia only an extreme example of diaphyseal aclasis. His summary is as follows: "The disease known to clinicians as multiple exostosis is a definite disorder of growth and should be named diaphyseal aclasis to indicate the nature of the growth disturbance. It is congenital in point of origin and affects only those parts of the skeleton which are developed from both cartilage and membrane. It is related to achondroplasia, and there is reason for suspecting that it may be due to a disturbance in the function of the glands of internal secretion, the thyroid gland being the one which is most likely to be at fault. The study of this disorder helps us to analyze the normal machinery of bone growth." While these multiple cartilaginous tumors may have something in common with Ollier's disease, the clinical picture of the latter makes the few recorded cases fall into a discrete and definite little group from the clinical standpoint.

Coon (9) added a typical case in a child with the right upper and lower extremities involved, showing lesions in the metatarsals and metacarpals of both sides of the body. He noted by roentgenogram of the long bones

[1] *Chondrodysplasia* is defined in the latest edition of Stedman's *Medical Dictionary:* "Chondrodysplasia—see chondralloplasia—the occurrence of cartilage in abnormal situations in the bony skeleton." *Dyschondroplasia* is defined as *chondrodystrophy* or *achondroplasia.* It thus seemed advisable to use the term *chondrodysplasia* in this paper.

[2] This terminology (aclasis) is not defined and seems at first sight obscure.

Fig. 1.

Fig. 2.

Fig. 3.

Figs. 1, 2, and 3. Roentgenograms July, 1920. The long bones of the left leg are short. The distal inch of the tibia is enlarged and in this area there is a deficiency of bone structure apparently cartilaginous for the most part. The bone is of coarse structure and appears in irregular strands and masses extending from the bony shaft into the cartilaginous portion. The ossification is best developed posterior to the central axis of the mass and is absent at the periphery except for a flaring of the cortex of the shaft at the proximal end of the mass.

There is no evidence of active destruction or effusion or infiltration. The epiphysis is only slightly and irregularly ossified. Similar changes are present at all the metaphyses of the long bones of the left leg except the proximal end of the fibula, in the left side of the pelvis, and in some of the left metatarsals. The phalanges are not shown. Where the epiphyseal line is visible, it appears of normal width and the epiphyses are much less affected than the metaphyses.

of the right side, an increase in density and longitudinal striation. There were exostoses of the olecranon, acromion, and coracoid processes and also of the humerus. The right upper extremity was 6.5 inches shorter than the left, while the right lower was 3 inches shorter than its fellow.

Bentzon (2) in 1924, while reporting 1 case of Ollier's disease, could find in the literature only 12 other similar cases. His views, which are of interest, may be summarized: "Ollier's disease represents the typical reaction of the bones against certain disorders in the innervation of their blood vessels. It is often confined to one-half the body. Masses of hyaline cartilage are found to follow paths similar to those of the arteries of the bones. The pathological processes in the bone tissue may be assumed to be related to the formation of callus in a fracture where the blood vessels have been interrupted." He disagrees with Ollier and Wittek (24), who described the disease as a disturbance of epiphyseal growth. He regards this as a secondary phenomenon. The primary focus is, he believes, in the diaphyses, which are nourished by a single large nutrient artery. From an experimental standpoint, working with rabbits, he was able, by interrupting the sympathetic nerves, in some instances to produce structural changes in bone similar to those seen in Ollier's disease. Bentzon's theories of the etiology of Ollier's disease, supported by his studies, form a valuable contribution.

Voorhoeve (22) presented cases of a brother and sister whose roentgenograms showed longitudinal striation of the metaphyses of the long bones and pelvis. These manifestations he considered allied to chondrodysplasia, but the symmetrical distribution places it outside the category of Ollier's disease. A valuable list of references is found in his presentation.

Jansen (11) reported a case of unilateral chondromatosis which he properly calls

Fig. 5.

Fig. 6.

Fig. 4.

Figs. 4, 5, and 6. Roentgenograms of March, 1926. The calcareous nodules noted in 1924 are more numerous now and more dense. The shaft of the left tibia is irregular in density, due to repair following osteotomy in 1925. The distribution of the lesions is the same as previously reported. The bones have grown in length. The growth occurs in the affected portions of the shaft. The left femur is wider than the right.

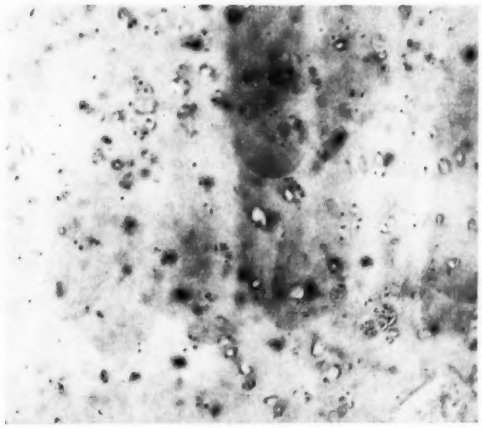

Fig. 7.

Fig. 7. Photomicrograph of tissue removed from lower metaphysis of tibia, January, 1927.

Ollier's disease. The pathological study of excised tissue showed cartilage cells of the myxomatous type.

Cole has written very concisely on this disease, giving summarized case reports on five patients besides his own, a clear-cut case of chondrodysplasia. He concludes as follows:

"1. Ollier's disease is a term which seems fixed in the literature but which should be used only to designate those cases of cartilaginous dystrophy, with or without cartilaginous tumor formation, which show an asymmetrical involvement of the body as the outstanding clinical feature.

"2. Chondrodysplasia is a condition which is usually asymmetrical but as several symmetrical cases are on record, the term must

Fig. 8.

Fig. 9.

Figs. 8, 9, 10, and 11. Photographs taken of the patient in 1927, at age of 9 years.

therefore be broader in its application than Ollier's disease.

"The gradation of reported cases between those of frank multiple cartilaginous exostosis, on the one hand, and the so-called chondrodysplasia with no change in anything except the internal architecture of the bones, on the other, is so varied and irregular that a definite classification of cartilaginous dystrophies is still impossible. The possibility that the widely different findings in some of these cases are only manifestations of different stages of the same condition must not be overlooked."

The cases of cartilaginous dystrophy which may be classified as Ollier's disease have been reported as follows:

	Cases
Ollier	2
Nové-Josserand and Destot	1
(These 3 cases were made the subject of Molin's thesis.)	
Wittek	1
Burchard	2
Koehler	1
Coon	1
Sven Johansson	1
Chris Johannesson	1
Bojesen	1
Bentzon	1
Jansen	1
Cole	1
Case reported here	1
Total	15

Fig. 10.

Fig. 11.

In 1924 Bentzon reported that he had found 12 cases in the literature besides his own, but there is probably a mistake in the first 3 cases. Bentzon ascribed 3 cases to Ollier and Molin and 1 to Nové-Josserand and Destot, but Molin's thesis was built up on a presentation of 3 cases, 2 of which were Ollier's and 1 that of Nové-Josserand and Destot.

A search of the literature since 1924 has shown only 3 additional cases. In 1925 Canelli (7) reported a case of cartilaginous dystrophy in an infant which lived but 2½ months, with lesions involving the metaphyses of both humeri and of both femora, the coxal bones and sacrum. The roentgenograms of this infant showed irregular deposits of calcium in the areas mentioned, a picture quite similar to that shown in Fig. 4, taken when our patient was 8 years old. This case is interesting as a picture of marked symmetrical skeletal deformity due to irregular growth of cartilage in the metaphyses of the long bones. It seems reasonable to consider this condition

Fig. 12.

Fig. 13.

Figs. 12, 13, 14, 15, and 16. Roentgenograms taken in October, 1927. In addition to the calcareous nodules previously noted, definite bone structure is appearing in the cartilaginous areas and these are assuming a more normal shape, with a thin bone shell over most of each lesion. The proximal and middle phalanges of both hands and feet and the left metatarsals show abnormal ossification, but there is here no evidence of nodular calcification.

as closely allied to Ollier's disease. In 1926 Mauclaire (17) reported a case which he called Ollier's disease but which obviously falls outside this group as commonly accepted. It is not asymmetrical and the roentgenograms do not show typical lesions.

The history of our case follows:

F. H., aged 2 years, No. 39872, appeared at the New York Orthopædic Dispensary in July, 1920, with a history of deformity of the left leg, noted first at the age of 6 months. The child was essentially normal on examination except for a difference in the length of legs. The right leg was 14½ inches long and the left leg was 12½ inches. The left tibia showed marked lateral bowing with the foot in varus deformity. The right foot was in valgus. Roentgenograms were taken (see Fig. 1, 2, and 3). The Wassermann was negative. No opinion was recorded regarding diagnosis, and no treatment suggested at this time.

He remained away from the dispensary for 3½ years, during which time he was seen at intervals of 6 months by the visiting nurse. His intervening history is without interest aside from the fact that there was a gradually increasing disparity in length between the right and left legs. He was forced to return to the dispensary when he could no longer walk.

In June, 1924, at the age of 6 years, the left leg was almost 6 inches shorter than the right, shortening being distributed equally between thigh and leg, with sharp lateral bowing of both tibia and fibula. An extension leg brace was ordered and an osteotomy to correct the deformity of left leg was suggested. A second roentgenogram was taken but, unfortunately, discarded. The report reads: "The same non-ossified and irregularly ossified areas are present, but there are a few dense calcareous nodules in the cartilaginous areas of the lesions."

July 21, 1924. The patient entered the hospital.

MEASUREMENTS OF LOWER EXTREMITIES

	Left Inches	Right Inches	Difference Inches
Total length anterior superior iliac spine to medial malleolus	14½	21	6½
Femur	7¼	11	3¾
Tibia	7¼	10	2¾

Left leg. There is moderate anterolateral bowing of the upper third of femur, which is considerably enlarged. Function at hip is normal. Knee shows normal muscle balance. There is marked posterolateral bowing of the lower third of the tibia. Both extremities of the tibia are enlarged, and there is 20 degrees of lateral torsion. The foot is rotated laterally 90 degrees. The Wassermann reaction was a

Fig. 14.

doubtful positive and tests made on both parents were negative, but the patient was given four injections of neosalvarsan on the remote chance that anti-luetic treatment might help. Following these treatments an uneventful year intervened. No history of any similar trouble could be elicited in any near or remote member of the patient's family.

June, 1925. The patient again entered the hospital ward. The left leg was noted as being 6 inches short. Although there is some discrepancy between the measurements of 1924 and those of 1925, which might be due to the range of error of different examiners, the disparity between the right and left leg remains the same.

MEASUREMENTS

	Left Inches	Right Inches	Difference Inches
Entire length anterior superior iliac spine to medial malleolus	14½	20½	6
Femur	7¼	10¼	3¼
Tibia	7¼	10	2¾
Circumference of thigh	12½	12	½
Circumference of calf	8½	8	½

An osteotomy of the tibia was done to correct the deformity. The bone was divided at a point below the center, where it was found to be quite brittle. This healed uneventfully with correction of deformity. The patient wore a plaster-of-Paris circular splint for two months and then bore weight with his extension brace.

For the next 18 months the patient returned to the dispensary at intervals of every 3 weeks. The condition remained unchanged. Another roentgenogram was taken in March, 1926 (See Figs. 4, 5, and 6).

January, 1927, age 9 years, the patient entered the hospital for an exploratory incision for the purpose of microscopic examination of the tissue. The Wassermann was negative, the Mantoux, negative. The blood count showed red blood cells 4,750,000; white blood cells, 14,800; hæmoglobin, 75 per cent; polymorphonuclears, 75 per cent; small lymphocytes, 20 per cent; large lymphocytes, 3 per cent; transitionals, 2 per cent. Urinalysis was negative.

At operation the periosteum was divided and the tibia was exposed at the lower metaphysis. It had a soft melon-rind consistency, and several pieces were removed for study.

Pathological report. Gross examination: The tissue consists of six small fragments of translucent, bluish-white homogeneous tissue resembling cartilage. Microscopic examination: Sections of cartilage show extensive cystic degeneration, small and large cysts being present. There are also several rather large, roughly circular spaces in the cartilage containing strands of delicate connective tissue.

Diagnosis. Cystic degeneration of cartilage (see Fig. 7).

There is nothing of moment to report until his most recent examination in September, 1927. See Figs. 8, 9, 10, and 11. Examination shows that all motions in the left leg are free and normal. General condition is excellent.

MEASUREMENTS SEPTEMBER, 1927

	Left Inches	Right Inches	Difference Inches
Anterior superior iliac spine to sole	19	25½	6½
Anterior superior iliac spine to medial malleolus	16½	23½	7
Femur	9¼	13¼	4
Tibia	7¼	10¼	3

Total height 46½ inches.

Roentgenograms were again taken at this time which show progressive change in the lesion (see Figs. 12, 13, 14, 15, and 16). It is interesting to note

Fig. 15.

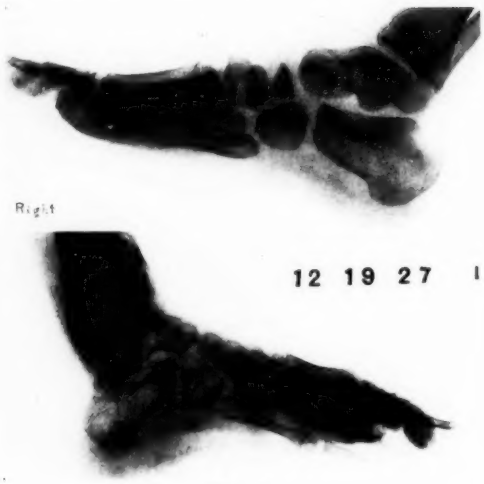

Fig. 16.

that at the age of 2 years the left leg was 2 inches shorter than the right. Four years later the disparity was 6½ inches. After a lapse of another 3 years, we find the left leg only 7 inches shorter than its fellow, which seems to indicate that for the past 3 years it has been almost holding its own in growth rate with the sound leg.

SUMMARY

This case is unquestionably a chondrodysplasia of the type called Ollier's disease. It is an asymmetrical cartilaginous dystrophy with resulting skeletal deformity confined to the left leg. It is undergoing delayed ossification and healing spontaneously, which is the usual course of events, according to Ollier. The affected long bones are growing. After having fallen behind 6½ inches in length during his first 6 years, for the past 3 years they have almost kept pace with those of the sound leg. The disease is extremely disabling because of the unilateral retardation of bone growth. Whether this is an unusual manifestation of the condition known as hereditary deforming chondrodysplasia or multiple cartilaginous tumors, as Keith believes, or is a distinct entity, as Ollier and others have believed, has not been proved. Ollier's statement that these cartilaginous masses undergo delayed ossification and tend to heal spontaneously, while the multiple chondromata never ossify, seems to indicate a fundamental difference. The history of this patient seems to lend weight to Ollier's conclusion. On the other hand, a study of the case reported by Canelli makes one wonder whether the asymmetric feature of this small group of cases might not be a coincidence. While these 15 patients may not represent an essential difference in pathology from that displayed by a much larger class of cartilaginous dystrophies, the clinical picture of each case is so very similar to the others that they seem to fall into a very clear-cut group. Bentzon's theory that this condition represents a disorder in the innervation of the blood vessels of the long bones and that the process is a circulatory disturbance is interesting.

The condition is rare and this case is added to the series with the hope that the observation of such a patient over a period of 7 years may be of some value. It is to be hoped that he may be studied until he reaches maturity.

BIBLIOGRAPHY

1. Ashhurst, A. P. C. Multiple cartilaginous exostoses (hereditary deforming chondrodysplasia). Ann. Surg., 1916, lxiii, 167.
2. Bentzon, P. K. G. Roentgenological and experimental studies in the pathogenesis of dyschondroplasia (Ollier's disease). Acta Radiol., 1924, iii, 89.
3. Bojesen. Ueber einen Fall von halbseitiger multipler Chondromatose. Fortschr. a. d. Geb. d. Roentgenstrahlen, 1917, xxiv, 113.

4. BURCHARD. Zur Diagnose der Chondromatosen, Fibrosen und zystischen Degeneration der Knocken. Fortschr. a. d. Geb. d. Roentgenstrahlen, 1912–13, xix, 113.
5. Idem. Ueber multiple Enchondrome in den langen Roehrenknocken von Kindern. Fortschr. a. d. Geb. d. Roentgenstrahlen, 1912–13, xix, 291.
6. CAMPBELL, HORACE E. Hereditary deforming chondrodysplasia; report of three cases. J. Bone & Joint Surg., 1925, vii, 982.
7. CANELLI, ADOLPHO F. Di un caso particolare di dischondroplasia. Clin. Ped. d. Regia Universita di Turino, 1926, p. 513.
8. COLE, WALLACE H. Chondrodysplasia. Surg., Gynec. & Obst., 1926, xlii, 359.
9. COON, CLARENCE E. Dyschondroplasia. Am. J. Orth. Surg., 1911, ix, 604.
10. EHRENFRIED, A. Hereditary deforming chondrodysplasia; multiple cartilaginous exostoses. J. Am. M. Ass., 1917, lxviii, 502.
11. JANSEN, J. W. F. Un cas de chondromatose unilatéral (Malade d'Ollier). Acta Radiol., 1925, iv, 133.
12. JOHANNESSON, CHR. Kasuistische Mitteilung z. Beleuchtung der Ollierschen Wachstumsstoerung. Monatsschr. f. Kinderh., 1923, xxv, 294.
13. JOHANSSON, SVEN. Ein Beitrag z. Kenntnis der sog. Ollierschen Wachstumsstoerung. Nord. med. Arkiv., 1916, Nr. 18.
14. KEITH, SIR ARTHUR. The nature of the structural alterations in the disorder known as multiple exostoses. J. Anat., 1920, liv, 101.
15. KOEHLER, A. Fortschr. a. d. Geb. Roentgenstrahlen, Ergangunband 12, 132. Die normale und pathologische Anatomie des hueft Gelenks und Oberschenkels in roentgenographischen Darstellung. Hamburg, 1905.
16. LEWIN, PHILIP. Multiple cartilaginous exostoses; diaphyseal aclasis. Surg., Gynec. & Obst., 1927, xlv, 48.
17. MAUCLAIRE. Un cas de nanisme par dyschrondroplasie d'Ollier. Rev. d'orthop., 1926, xiii, 653.
18. MOLIN. La dyschondroplasie. Thèse, Lyon, 1900.
19. OLLIER, LOUIS-X.-E.-L. Bull. de la Soc. de Chir. de Lyon, 1899–1900, iii, 22.
20. ORD, A. G. A case of hereditary deforming chondrodysplasia. Lancet, 1925, ii, 178.
21. PERCY, N. M. Multiple chondro-osteoma. Surg., Gynec. & Obst., 1915, xx, 619.
22. VOORHOEVE, N. L'image radiologique non encore décrite d'une anomalie du squelette. Acta Radiol., 1924, iii, 407.
23. WHITE, RENFREW. Two rare bone diseases. Brit. J. S., 1924, July, 76.
24. WITTEK, ARNOLD. Die Olliersche Wachstumsstoerung. Bibliotheca medica, E 7, Stuttgart: E. Naegele, 1906.

MULTIPLE POLYPOSIS OF THE COLON[1]

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THE term polyposis of the colon has been interpreted by different writers at various times to mean a single polyp, scattered polypi, or an actual polyposis in which we find the entire large bowel, including the rectum, the seat of thousands of sessile adenomatous tumors. The finding of a single polyp is certainly not a rare occurrence; neither are multiple or scattered single polyps in the same bowel uncommon. Areas of polyposis, which are the result of ulcers, strictures, carcinoma, or other mucous membrane irritation are frequently encountered, but we still have remaining that type of polyposis which occurs most often in young people and in which the normal mucosa is entirely replaced by countless small tumors of approximately the same size. This latter form has been very correctly named by Erdmann and Morris "adolescent, congenital, disseminated polyposis," in contradistinction to all other forms.

Lockhart-Mummery classifies the adenomata occurring in the bowel as follows: (1) true multiple adenomata; (2) polyps associated with hyperplastic tuberculosis; (3) multiple polyps associated with old stricture of the colon; (4) polypoid condition resulting from ulcerative colitis. An inspection of these groups shows that they fall very nicely into Erdmann's classification, the first being the adolescent type, found in the youth with the congenital predisposition, the three remaining groups the result of one kind or another of irritation or trauma to the mucosa.

The classification of Erdmann and Morris made on a clinical basis, comprises two forms: (1) adult acquired type and (2) adolescent congenital, disseminated type. They place in the first group the single polyp. In view of the fact that single polyps are sometimes found in very young children, it might be suggested that the terms adult and adolescent be omitted, they being called simply congenital and acquired. Further, the term adolescent might be confusing, in that while the condition in the second group is undoubtedly the result of a hereditary predisposition, at the same time it occasionally does not manifest itself until after adolescence.

The congenital form usually becomes evident in childhood or youth, rarely has a discoverable associated and etiological lesion, is often shown in other members of the family, and has a high malignancy incidence.

HISTORICAL

Menzel, in 1721, reported a case of what has all the earmarks of the congenital type, in a boy of 15 years. In 1832, Wagner, and in 1839 Rokitansky reported cases of multiple polyposis, the type of which is uncertain. Lebert's case reported in 1861, a female aged 32 years, is the first description of the polypi themselves. The case reported by Luschka in the same year was in a woman aged 30 years. In this case the mucosa of the entire colon and rectum had been replaced by polyps. In Woodward's case, a woman aged 44 years, the entire colon, including the rectum showed polyps. Virchow, at this time, reviewed a case of his and of Lebert and of Luschka, under the term "colitis polyposis cystica." Von Port collected 14 cases which were added in a tabulated list to 35 more collected from the literature by Doering, in 1907. In this series are given two personal cases of Doering's. Soper, in 1916, added 8 more cases. Struthers, in 1920, reviewed 39 cases of multiple polyposis of the intestinal tract, and in 1924, 20 cases of multiple polyposis of the gastro-intestinal tract. In this series a number contained polyps in the small bowel and stomach. These possibly do not belong in a series of cases of polyposis of the colon, but have been included. Likewise, a number of cases in the same series have been excluded because of insufficient data to make it permissible to list them as true cases of multiple adenomata.

A review has been made of the above mentioned cases and others, which including the writer's, totals 127. Following the scheme set by Doering, the 127 collected cases have been

[1] From the Miller Clinic.

classified under the headings of age, sex, site, duration of symptoms, malignancy, hereditary tendency, treatment, and results, and an attempt has been made to draw some conclusions from the information collected. Since all cases listed as multiple polyposis of the colon are included, it is probable that a number at least do not belong to the congenital type, although a number which were given in sufficient detail to mark them as obviously belonging to the acquired type were excluded.

AGE

Quénu and Landell report that over 50 per cent occur between the ages of 15 and 35 years. Cripps saw three cases in the same family, one aged 20, another 17, and the third 16 years of age. Erdmann had two male patients 14 and 16 years of age, and one female aged 22 years. The writer's case was that of a male, aged 32, whose brother succumbed to a multiple polyposis (proved at autopsy) at 34, and the father at 44, after having been ill with bowel trouble for years. Of the 127 cases, the ages are given in 93. The average age is 30.9 years, divided as follows:

	Cases
Under 10 years	5
10 to 20 years	23
20 to 30 years	21
30 to 40 years	23
40 to 50 years	11
50 to 60 years	4
60 to 70 years	5
70 to 80 years	1

The youngest patient was 5 years, the oldest 74. The number of patients between 15 and 35 years, for which period Quénu and Landell quote as 50 per cent, was 63, or 65.6 per cent, in this series. This is especially significant when one considers the following paragraph.

DURATION OF SYMPTOMS

The duration of the symptoms was noted in 60 of the 127 cases as follows:

	Cases	Per cent
"Since infancy"	5	8.3
"Years"	9	15.2
Over 10 years	9	15.2
5 to 10 years	8	13.3
4 to 5 years	4	6.1
3 to 4 years	7	11.8
2 to 3 years	6	10.1
1 to 2 years	7	11.8
Less than 1 year	5	8.3

Of the 60 cases in which we know the duration of symptoms, 31, or approximately one-half, have probably had symptoms 10 years, thus the average age of 30.9 years would have been reduced materially, if these patients had been discovered and their condition had been diagnosed earlier.

SEX

It has been generally supposed that males are more frequently affected. However, in this series there was only a slight difference. Of 98 in which the sex was given, 52, 53 per cent, were males and 46, 47 per cent, were females.

SITE

The area involved was given in 106 cases as follows:

	Cases	Per cent
"Rectum and colon"	44	41.8
Rectum alone	26	24.7
Colon	22	20.9
Large and small bowel	11	10.4
Large, small bowel and stomach	1	0.9
"Rectosigmoid junction"	1	0.9
Cæcum and colon	1	0.9
Total	106	

MALIGNANCY

In many of the cases the question of malignant change has not been settled; in fact, very often it could not, from the nature of the case, be accurately determined. However, in 44 cases, or 34.6 per cent, of the total, carcinomatous change was either present at the time the diagnosis was made or occurred later. This is a decrease of 8.4 per cent from Doering and Soper's series in which the malignancy was 43 per cent.

When we consider that 42 of the 127 cases were known to have malignant disease, and that 31 more in whom the question of malignancy remained in doubt died rather early of cachexia, inanition, or bleeding, it is only fair to suppose that the malignancy index in the series is actually higher than the figures represent. Mummery states that "almost all recorded cases of multiple polypi of the colon eventually become malignant," and this was the factor to be reckoned with in treating these cases.

TABLE I.

Author	Age, sex	Duration	Site	Malignancy	Treatment	Result	Family history	Cause of death
1* Sklifasowski	M 51	7 yr.	R					
2 Cripps	M 19	10 yr.	R-C		Snaring of polyps	Improved	1 sister	
3 Whitehead	M 21	10 yr.	R-C		Snaring of polyps	Improved		
4 Smith	M 20	10 yr.	R-C	Carcinoma		Died	Brother and sister	
5 Guillet	M 24		R-C-Cæcum			Died		Intussusception.
6 Handford	F 34		R-C	Carcinoma		Died		Carcinoma.
7 Bickersteth	M 11	4 yr.	R		Removal of polyps	Improved	Mother	
8 Dalton	F 28	2 yr.	R-C-Cæcum			Died		Bleeding.
9 Paget	M					Died	2 sisters	Bleeding.
10 Makins	F 20		R	Carcinoma		Died		Carcinoma.
11 Paget	F		R	Carcinoma		Died	Brother and sister	Carcinoma.
12 Treves	M 20			Carcinoma		Died		Carcinoma.
13 Geissler	M 19	Since early childhood	R-C-Cæcum			Died		Intussusception.
14 Hellferich	M 19	Since early childhood	R-C-Cæcum-Stomach	Carcinoma		Died		Carcinoma.
15† Luschka	F 30	15 yr.	C-R	Carcinoma		Died		Inanition.
16 Lebert	F 32	1 yr.	C-R			Died		Inanition.
17 Wulf	M 34	Yrs.	C-R	Carcinoma		Died		Carcinoma.
18 Bardenheuer	M 48	1 yr.	C-R-Cæcum	Carcinoma		Died		Carcinoma.
19 Hauser	M 30		C-R	Carcinoma		Died		Carcinoma.
20 Hauser	F		TC-Sigmoid	Carcinoma		Died		Carcinoma.
21 Petrow	F 21	Yrs.	Ileo-cæc. valve, ileum to jejunum		Resection of intussusception	Died		Intussusception.
22 Lindner	F 15	Yrs.	R	Carcinoma	Amputation of rectum	Well 4 years, died		Carcinoma.
23 Lubarsh	M 62		R-C and term. il.	Carcinoma		Died		Carcinoma.
24 Rotter	M 34	Yrs.	R-C			Died		Bleeding.
25 Rotter	F 31	Yrs.	R	Carcinoma		Died		Carcinoma.
26 Meyer	M 42	4 yr.	R-DC	Carcinoma		Died		Carcinoma.
27 Horand			R					
28 Vergely	F 23	6 yr.	R					
29 Reiderer	F 38	Yrs.	R-Cæcum-TC		Resection of colon	Died		Peritonitis
30 Karajan								
31 Henle		Yrs.	Ileo-cæcal region	Carcinoma	Resection of colon	Well		
32 Cathelin	M 5		Entire int. tract					Bleeding.
33 Schmidt			Sig.-R	Carcinoma		Died		Carcinoma.
34 Niemack	F 12	4 yr.	R-C-term. ileum			Died	Father; cousin	Inanition.

*Cases 1 to 14, inclusive, Von Port, Deutsche Ztschr. f. Chir., xlii.
†Numbers 15 to 50, inclusive, Doering, Arch. f. Klin. Chir., lxxxiii.

TABLE I.—Continued

Author	Age, sex	Duration	Site	Malignancy	Treatment	Result	Family history	Cause of death
Niemack[35]	M 40	2 yr.	R-C	Carcinoma	Amputation of rectum			
Niemack[36]	M 29	3 yr.	R				Uncle	
Zahlmann[37]	F 23		C-Ileo-cæcal valve	Carcinoma		Died	6 brothers and sisters	Carcinoma.
Lewerenz[38]			Ileo-cæcal region		Resection of intussusception	Well		
Margerini[39]	M 31	Yrs.	R	Carcinoma		Died		Carcinoma.
Funkenstein[40]	F 24	2 yr.	Pylorus-duodenum-cæcum-C-R			Died		Bleeding.
Schwab[41]	M 37	15 yr.	C-R			Died		Bleeding.
Schwab[42]	F 18	Yrs.	R		Removal of polyps	Improved		
Pope[43]	F 25	2 yr.	TC			Died		Inanition.
Holtmann[44]	M 54	5 yr.	C-Cæcum	Carcinoma		Died		Carcinoma.
Hauser[45]	M 33	3 mo.	Duodenum-R-sigmoid flexure, splenic flexure	Carcinoma		Died		Carcinoma.
Hauser[46]				Carcinoma		Died		Carcinoma.
Hauser[47]				Carcinoma		Died		Carcinoma.
Doering[48]	M 16	6 yr.	Duodenum-R-C	Carcinoma		Died	1 sister	Carcinoma.
Doering[49]	F 20	2 yr.	R			Improved	1 brother	
Vajda[50]	9	3 yr.	R-C			Died		Inanition.
Coffey[51]	F 38	9 yr.	C-R-sigmoid	Carcinoma	Total colectomy with ileostomy	Well		
Wheeler[52]	F 26	2 yr.	C-R-sigmoid		Ileosigmoidostomy	Died		Postoperative
Wheeler[53]	F 16	10 yr.			Removal of cuff of mucosa, colostomy, resect. 8¼ inches of bowel	Improved		
Erdmann and Morris[54]	M 14	Early childhood						
Erdmann and Morris[55]	M 16	Yrs.						
Erdmann and Morris[56]	F 22	4 yr.			Appendicostomy, ileosigmoidostomy	Well	Father	
Erdmann[57]	M 17	7 yr.	C		Appendicostomy, colectomy, ileosigmoidostomy	Improved		
Erdmann[58]	M				Not given		1 daughter	
McKenney[59]	M 35	10 yr.	R-sigmoid		Snaring of polyps	Great improvement		
Yeomans[60]	M 29	14 mo.		Carcinoma	Colostomy, irrigations, then ileostomy	Improved, then died		Carcinoma.
Justi[61]	M 19	6 wks.						
Pennant[62]	M 30	Yrs.		Carcinoma	Complete removal	Died		Postoperative
Pennant[63]	M 32	Yrs.		Carcinoma	Colostomy			
Murphy[64]	M 36	10 yr.	Sigmoid	Carcinoma	Removal of polyps by enterotomy	Well		
Bratrud[65]	F 16	1 yr.	Sigmoid, ileum		Reduction of intussusception, removal of polyps	Well		

TABLE I.—Continued

Author	Age, sex	Duration	Site	Malignancy	Treatment	Result	Family history	Cause of death
66 Newbolt	F 20		R-sigmoid		Removal of polyps with cautery	Improved		
67 Newbolt	F 29	1 yr.	R	Carcinoma	Amputation of rectum			
68 Furnivall	M 48	1 yr.	Sigmoid	Carcinoma	Removal of 10 inches of sigmoid			
69 Furnivall	M 50	3 yr.	R	Carcinoma	Removal of rectum			
70 Norbury	M 32	8-9 yr.	R-pelvic colon		Appendicostomy	Symptoms improved, polyps the same		
71 Watson	M 41		Sigmoid	Carcinoma	Removal of carcinoma of sigmoid	Well 4 yr.		
72 Bock	F 24	3 yr.	R-sigmoid, TC	Carcinoma	Abdominal-perineal excision	Well 6 mo.		
73 Hewitt and Howard	F 36	Long time	C-R			Died		Inanition.
74 Hewitt and Howard	M 40	2 mo.	C-sigmoid-R	Carcinoma		Died		Carcinoma.
75 Woodward	F 44	1 yr.	C-R			Died		Inanition.
76 Soper	M 8	Since infancy	R-C		Total colectomy with ileosigmoidostomy	Well		
77 Carroll	M 38	3 mo.			Removal of 6 inches of ileum, ascending colon, transverse colon, ileocolostomy	Recovered		
78 Babbler, Niebrugge, and Fisch	F 19	3 yr.	C-sigmoid	Carcinoma	Appendicostomy	Died		9 days postoperative, exhaustion.
79 Oseki	F 31	1 yr.	R-C	Carcinoma		Died		Carcinoma.
80 Tupper	M 10		R-C		Colostomy	Died 58th day		
81 Esser	M 29		R-C		Colostomy	Recovery		
82 Terrell			R		"Local treatment"			
83 Lilienthal	F 20		Entire colon, rectum free		Colectomy with ileosigmoidostomy	Well		
84 Von Bokay	6		C		Appendicostomy	Died		Shock.
85 Dunn, J. N.	M 27	5 yr.	R-sigmoid		Medical	Died	1 brother	Inanition.
86 Struthers	M 50		R		Resection of anus, rectum, 10 cm. of sigmoid	Well 3 mo. later		
87 Struthers	F 27		C		Ileostomy	Well at 3 mo.		
88 Struthers	M 62		Sigmoid		Colostomy, resection of part of sigmoid, part of rectum	Well at 8 mo.		
89 Struthers	F 50		R		Resection of anal canal, 5 cm. of rectum	Improved at 3 mo.		
90 Struthers	F 67		R	Carcinoma	Colostomy, excision of anus and rectum	Improved at 8 mo.		
91 Struthers	F 44		R		Colostomy	Died		Pneumonia.
92 Struthers	F 27		R		Ileostomy	Died		Exhaustion.
93 Struthers	M 51		R	Carcinoma	Exploratory, radium	Died		Carcinoma and exhaustion.
94 Struthers	F 47		R-sigmoid		No treatment			
95 Struthers	M 49		R		No treatment			

TABLE I.—Continued

Author	Age, sex	Duration	Site	Malignancy	Treatment	Result	Family history	Cause of death
96 Struthers	F 55		Sigmoid		No treatment			
97 Struthers	F 17		C		No treatment	Died		
98 Struthers	M 74		R-C		Radium	Failing at 4 mo.		
99 Struthers	M 70		R-sigmoid		Medical	Failing at 20 mo.		
100 Warwick	F 36	9 mo.	C-small intestine	Carcinoma	Excision of mass at hepatic flexure	Died		Peritonitis.
101 Warwick	M 38	7 mo.	Recto-sigmoid	Carcinoma	Operated on but procedure not given	Died		Metastatic carcinoma and exhaustion.
102 Morrison	M 13		R		Colostomy, saline irrigations 18 mo., colostomy closed; polyps disappeared			
103 Lockhart-Mummery	F 22	6 yr.	Ileum to anus		Ileoproctostomy	Well		
104 Creyx and Massias	M	4 mo.	C-R			Died		Carcinoma.
105 Alley	F 64	30 yr.	Cæcum-C		Ichthyol enemata, alum hydroxide	Improved		
106 Author's case	M 32	5–10 Yr.	Ileum to anus	Carcinoma	Ileostomy, total colectomy (Coffey technique)	Died	Brother and father	Died 4th day postoperative
107 Struthers			C		Ileostomy, ileocolostomy	Died		
108 Struthers			R		Transfusion	Died		
109 Struthers					Ileostomy	Died		
110 Struthers			R sigmoid		Colectomy with 5 inches of ileum	Died		
111 Struthers			C		Ileostomy, colectomy, except 5 inches of sigmoid	Improved		
112 Struthers			R-sigmoid		Ileostomy	Improved		
113 Struthers			Sigmoid		Ileostomy, ileo-sigmoidostomy	Improved		
114 Struthers			C		Ileostomy	Excellent		
115 Struthers			C	Carcinoma	Exploratory, then medical	Died		Carcinoma.
116 Struthers			R-C-sigmoid	Carcinoma	Medical	Died		Carcinoma.
117 Struthers			Large bowel		Medical	Died		
118 Struthers			R-C	Carcinoma	Operation not given	Improved		
119 Struthers			R-C		Medical	Improved		
120 Struthers			C		Medical	Improved		
121 Struthers			R-C		Medical	Improved		
122 Struthers			C		Medical	Unimproved		
123 Struthers			Bowel		Medical	Improved		
124 Struthers			C		Medical	Died		
125 Struthers			R		Medical	Unimproved		
126 Struthers			C		Medical	Improved		
127 Struthers					Medical	Improved		

FAMILIAL TENDENCY

A feature of congenital polyposis which would undoubtedly be more evident, if information were available, is the inherited predisposition of members of a family to exhibit this disease. Mummery says: "It appears to be a hereditary condition, as it can be traced through several generations, and the curious thing is that in such families a large proportion of individuals die at a comparatively early age, from cancer of the bowel." Dukes shows charts of three families. In the first family one daughter had multiple adenomata, while her mother, six uncles and aunts, and her grandfather died of cancer of the large bowel. In the second family two members are suffering from cancer of the rectum or multiple adenomata, four aunts and uncles are involved, and both paternal grandparents. In the third family five members of the family, involving three generations on both sides, either have died of cancer of the colon or have multiple polyposis. In the writer's case the patient, his brother, and father died of cancer, superimposed, as we know, in the case of one of the two sons and probably in that of the father, on a multiple polyposis. In the series of cases analyzed, a definite hereditary tendency was noted in 13 cases, or 11.1 per cent.

MORTALITY

In the entire series there were 61 known deaths, 47.2 per cent.

TREATMENT

Fifty-one cases, 40.2 per cent, are known to have been treated surgically. On the cases in which the treatment was either medical or not stated, insufficient data were given to draw any conclusions as to methods. In the 51 cases operated upon there were 18 deaths, a mortality of 35.1 per cent. In the remaining cases, there were 44 deaths, a mortality of 56.5 per cent.

TYPES OF OPERATION

These are given more to show the number of procedures used than to make any deduction from the results. The type of operation performed was given in 51 cases, as indicated in the following table:

	Cases
Colostomy	8
"Removal of rectum"	5
Ileostomy alone	5
Colostomy with removal of part of colon	4
Appendicostomy	3
Resection of intussusception	3
Total colectomy with ileostomy	2
Ileo-proctostomy	1
Ileo-sigmoidostomy	7
"Resection of colon"	2
"Excision of mass at sigmoid flexure"	1
Complete colectomy with 5 inches of ileum	1
Exploratory	2
Resection of part of sigmoid	3
Resection of anal canal and rectum	1
Total colectomy with ileosigmoidostomy	1
Ileocolostomy with removal of part of ileum, transverse and ascending colon	1
Ascending abdominoperineal excision	1

In a consideration of the surgical procedure to be undertaken, it immediately becomes evident that the type of operation depends on certain features in each individual case, viz., malignancy, extent of involvement, condition of the patient, and the technical ability and surgical experience of the operator.

The usual extensive involvement in the congenital type of case renders a complete removal of the entire polyp-bearing area a more or less heroic task. Erdmann says that the problem, first, is one of the determining of the extent of the process before operation. This can sometimes be done by palpation of the thickened gut-wall as was possible in Carroll's patient. In our own case, the entire bowel from ileocæcal valve to the anus, was so markedly thickened and doughy that a diagnosis of the extent was immediately possible when the abdomen was opened. In such a case it would seem useless to remove a part, even though that part had already undergone malignant change, and to allow to remain, other highly potentially malignant tissue, or tissue which may already have become malignant, since several separate and apparently primary cancerous areas have been found in the same case. Lilienthal, Soper, and Erdmann have successfully done total colectomies with ileosigmoidostomies. Coffey was the first, and I believe so far the only one, to remove successfully the entire colon, sigmoid, rectum, and anus, with a permanent ileostomy in the treatment of this condition. The author's patient was operated upon after Coffey's technique for colectomy, but died on the fourth day. Less radical

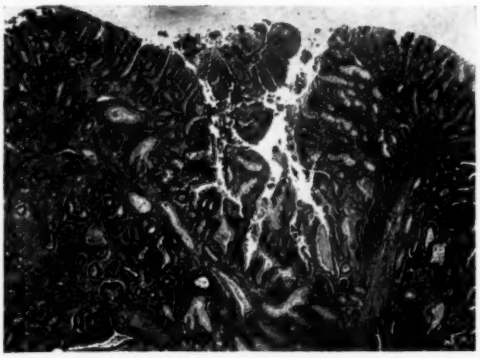

Fig. 1. Benign polyp. Glands are small and regular.

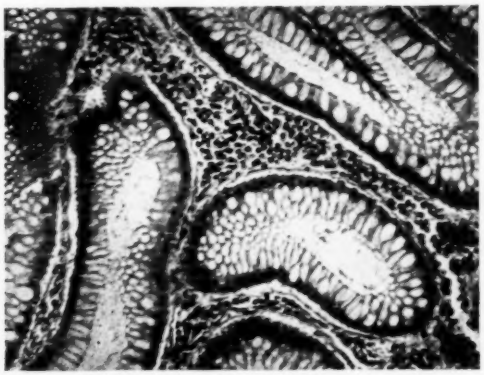

Fig. 2. High magnification of benign polyp. Glands are lined with normal epithelium of the columnar type. Cells are filled with mucus.

methods have been tried, and for the most part, found wanting. Appendecostomy has failed entirely in some cases; in others it has afforded relief while the opening existed, only to have the disease start with renewed vigor when the appendecostomy was closed. Radium has been tried with reports of improvement, but no cures. Deep X-ray therapy had no apparent effect on our case, which was observed through the proctoscope months afterward for signs of retrogression.

Erdmann ends his discussion of treatment thus: "One may sum up the present status of treatment of this condition by saying that the only method which holds out any hope for cure in the disseminated variety is one imposing upon the operator great technical difficulties, upon the patient great danger, and upon both the possibility that a successful operation may prove fruitless because the operator has been unable to determine accurately the extent of the process and has, therefore, left behind areas capable of transmitting all the original potentialities of the disease."

The writer's patient was a man 34 years of age who came to the Miller Clinic in September, 1925, complaining of a persistent diarrhœa with bloody stools. He gave a history of having had bowel trouble all his life, having what he called an "irritable bowel." For 10 years he had had several stools a day, often containing blood. He had lost 20 pounds in weight, but felt comparatively well and up to this time had been able to do his work without loss of time because of illness. His appetite and digestion were good and his chief complaint was that his frequent stools (at that time ten to twenty daily) inconvenienced him greatly.

His father had died of "bowel trouble" after having been ill for a long time, and a brother had been operated on and found to have a multiple polyposis of the colon, from which he died.

He was proctoscoped and numerous small and several large polyps were seen, the small ones covering the wall of the rectum and sigmoid as far as could be seen.

Several of the larger tumors were removed with the snare and sectioned. These were about 1 centimeter in diameter and were attached by short pedicles. Microscopic sections (Figs. 1 and 2) showed a center of connective tissue surrounded by normal mucous glands lined by high columnar epithelium which was thrown into folds corresponding to the irregularities of the surface. The epithelium, however, was entirely normal in its type of growth, with no suggestion of any malignant process.

Patient was seen about once a week and each time several of the largest polyps were snared off, until finally the rectum and lower sigmoid were comparatively free from the single ones, only the velvety, thickened surface caused by the myriads of small tumors being left. At the end of 4 months the stools had decreased in number from fifteen or more a day to one or two a day, and he had gained 20 pounds in weight.

About this time it was decided to try deep X-ray therapy and he was given a course, with a rather severe reaction, but no appreciable diminution in the number or size of the polyps which were watched hopefully at intervals of 2 or 3 weeks for some signs of retrogression.

In August, 1927, after he had been absent from the Clinic for 3 months, he presented himself with the complaint that he was now having more irritation and that his bowel movements were again more frequent. Proctoscopic examination showed a reddened, irregular, somewhat indurated mass 2 centimeters in diameter, projecting into the lumen of the bowel at the rectosigmoid junction. This was quite different

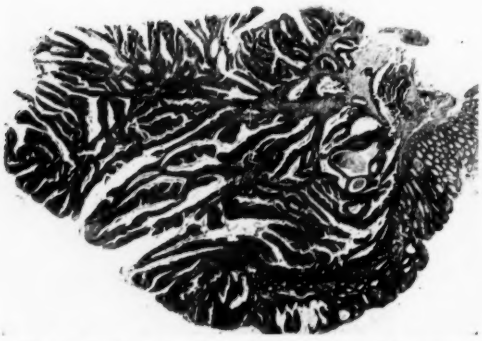

Fig. 3. Section of malignant polyp removed in summer of 1927. The glands are large and irregular.

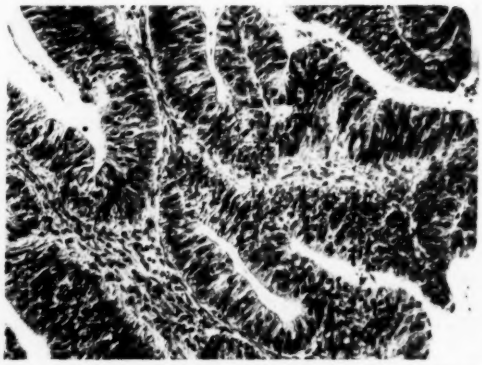

Fig. 4. High magnification of malignant polyp. Giant glands lined with atypical columnar epithelium.

in appearance than at any of the previous examinations, and a specimen was taken for microscopic examination, with a tentative diagnosis of carcinoma.

Microscopic section (Figs. 3 and 4) showed no connective tissue present but the entire mass consisted of very large glands of irregular shape lined by atypical, large epithelial cells which showed many mitotic figures and large hyperchromatic nuclei and grew in a lawless manner. From the size and irregularity of the glands and the comparative undifferentiation of the epithelium, a diagnosis of adenocarcinoma was made.

The problem before us was this: a young man, two of whose family had died of a multiple polyposis had one known malignant and another possibly malignant area in his bowel. An exploratory operation to determine, if possible, the extent of the polyposis, and the presence or absence of other malignant areas was advised, our idea being to make an ileostomy if it were considered feasible.

On September 13, the abdomen was opened. The thickened and doughy feeling of the colon promptly proved the presence of the polyps as far as the ileocæcal valve. An ileostomy was done and the patient was returned to bed. He soon began to show signs of obstruction and the ileostomy had to be opened prematurely, but we were fortunate enough to escape with little or no infection. After a stormy few days in which the drainage was inadequate he did very well, and by September 30, the discharge was the consistency of a normal stool and he was deemed to be in good condition for his second operation.

On this date a total colectomy, after the method described by Coffey, was done, the anus and rectum being left and a quarantine pack inserted. Although his pulse was rapid he stood the operation well. He took fluids freely by mouth and seemed to be doing very well until the evening of the third day when he began to regurgitate small amounts. This continued in spite of gastric lavage and other procedures and his condition grew worse gradually until the morning of October 4, when he died.

The colon removed at operation (Fig. 5) showed a polyposis which extended from the rectum up to the ileocæcal junction. At no point was any mucosa visible but placed close together on the inner surface were countless projections. For the most part these were small and triangular in shape with the base attached to the wall and the tip extending into the lumen of the bowel. They measured about 3 to 5 centimeters in length and were covered by high columnar epithelium which was normal in appearance. At various points throughout the colon were other large polyps usually attached by a pedicle long enough to allow them to extend well out beyond the smaller ones. These measured 1 to 3 centimeters in diameter and presented irregular surfaces. Microscopic sections showed them to be identical with those which had been removed in 1925 and 1926. The polyps of the colon were of all sizes and shapes, varying from tiny, triangular ones to large pedunculated ones but none of them showed any signs of malignancy.

The autopsy was performed October 4. There was an absence of the colon, and the rectum remained as a necrotic stump covered by a fibrinous exudate. Cross section showed the wall to be necrotic. On the mucosal surface was a raised annular ulcerated area with thick, firm, overhanging necrotic edges giving the picture typical of a malignant process but with no suggestion of its having arisen from a polyp. Microscopic section (Fig. 6) showed it to consist of large masses of epithelial cells which were atypical in appearance and which were making a poor attempt at gland formation. The epithelial growth had infiltrated the entire wall and extended back under the normal epithelium.

There was also a small but active tuberculous lesion in each lung, the apex on the right and the upper part of the lower lobe on the left. These consisted of a puckered scar surrounded by small tubercles in some of which there was a small amount of caseous necrosis. There was also a small abscess in the anterior abdominal wall at the upper edge of the incision,

Fig. 5. Entire colon removed at operation. The smaller mass in corner is rectum removed at necropsy.

but it was well circumscribed. No sign of inflammation was found except in the stump of the rectum and this was entirely localized. No anatomical reason for death was found.

CONCLUSIONS

1. There are two distinct types of polyposis: acquired and congenital.

2. Multiple polyposis is most common in childhood and youth, the average age in this entire series being 30.9 years, with over 65 per cent occurring before 35.

3. The symptoms usually persist for a long time before medical attention is sought.

4. Males and females are affected about equally.

5. The probability of malignant change is high, in this series 34.6 per cent.

6. There is a definite hereditary tendency.

7. The mortality is high, 47.2 per cent under all forms of treatment.

8. The treatment is not yet standardized.

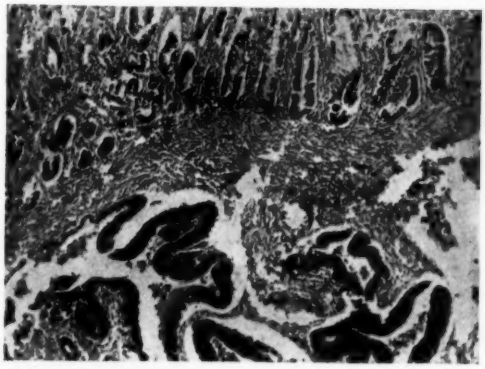

Fig. 6. Section of rectum removed at necropsy, showing irregular masses of atypical epithelium.

REFERENCES

1. Alley, R. G. A case of multiple polyposis of the intestine. Clifton Med. Bull., 1926, xii, No. 4.
2. Bock. Proc. Roy. Soc. Med., vii, 192.
3. Bratrud, Theo. Surg., Gynec. & Obst., 1914, xix, 31.
4. Babbler, Niebrugge, and Fisch. J. Am. M. Ass. 1909, lii, 1235.
5. Creyx, D., and Massias, C. Recitite et Colite Proliferantes, Polyadenomatose du colon, sclerose de la tête du pancreas. J. méd. de Bordeaux, 1921, li, 573.
6. Carroll, William. Surg., Gynec. & Obst., 1915, xx, 412.
7. Coffey, R. C. Colonic polyposis with engrafted malignancy. Surg., Gynec. & Obst., 1926.
8. Doering, Hans. Die polyposis Intestini und ihre Beziehung zur carcinomatosendegeneration. Arch. f. klin. Chir., 1907, lxxxiii.
9. Dunn, J. N. Personal communication.
10. Drueck, C. J. Benign tumors of the lower bowel. Am. Med., April 1920, p. 204.
11. Dukes, Cuthbert. Simple tumors of the large intestine and their relation to carcinoma. Proc. Roy. Soc. Med., 1925–26, xix, Sect. Surgery, Subsection Proctology, p. 9.
12. Erdmann, J. F., and Morris, J. H. Polyposis of the colon. Surg., Gynec. & Obst., April, 1925, xl, 460.
13. Erdmann, Robert. Polyposis coloni. Ann. Surg., 1917, lxvi, 231.
14. Esser. Quoted by Soper.
15. Furnivall, P. Three cases of multiple polyposis of the rectum and large intestine. Proc. Roy. Soc. Med., 1913–14, vii, Sect. Surgery, Pt. III, p. 245.
16. Hewitt and Howard. Arch. Int. Med., 1915, xv, 142.
17. Justi, Karl. Colitis hyperplatica polyposa dysenterica. 1921, ccxxxiv, 30–42.
18. Lockhart-Mummery. Proc. Roy. Soc. Med., 1918–19, Sect. xii, Surg. p. 43.
19. Lilienthal. Quoted by Soper.
20. Menzel. Quoted by Hewitt and Howard.
21. Morrison, Rutherford. Proc. Roy. Soc. Med., 1913, vii, 198.
22. Murphy, John B. Surg. Clin., Chicago, 1916, v, 447.
23. McKenney, D. C. Multiple polyposis of the colon. conservative treatment. Tr. Am. Proct. Soc., 1925.
24. Newbolt, G. Proc. Roy. Soc. Med., 1913, vii, p. 272
25. Norbury. Proc. Roy. Soc. Med., 1913, vii, p. 195.

26. Osaki. Deutsche Ztschr. f. Chir., 1912, cxviii, 463.
27. Pennant. Brit. M. J., 1925, p. 356.
28. Quénu and Landell. Rev. de gynéc. et chir. abd., Paris, 1899, iii.
29. Soper, Horace W. Polyposis of the colon. Am. J. M. Sc., 1916, 151, 405.
30. Struthers, J. E. Multiple polyposis of the intestinal tract. Ann. Surg., xxvii, 649.
31. Idem. Multiple polyposis of the gastro-intestinal tract. Surg., Gynec. & Obst., 1924, xxxviii, 610.
32. Terrell. Quoted by Soper.
33. Von Port. Deutsche Ztschr. f. Chir., xlii.
34. Von Bokay. Quoted by Soper.
35. Virchow. Quoted by Struthers.
36. Wheeler, W. I. de C. Multiple polypi of the colon. Brit. J. Surg., 1926, xiv, No. 53.
37. Watson. Proc. Roy. Soc. Med., vii, Pt. 3, p. 194.
38. Woodward. Am. J. M. Sc., 1881, lxxxi, 142.
39. Warwick, M. Intestinal polyposis and its relation to malignancy. Minnesota Med., 1922, Feb.
40. Yoemans, Frank. The carcinomatous degeneration of rectal adenomas. J. Am. M. Ass., 1927, lxxxix, 852.
41. Tupper. Quoted by Soper.

HÆMATOMETRA

A Report of Twenty-Three Cases[1]

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THE retention of blood within the uterus is not uncommon but is not as common as might be expected if one considers the numerous opportunities in the average female for the occurrence of obstruction in the lower portion of the genital tract. Besides the congenital anomalies of the uterus and vagina, that are frequently obstructive in type, many pathological conditions occur in the lifetime of a woman which may result in an acquired obstruction at some point within the lower portion of the genital tract, usually within the cervical canal. The trauma of childbirth, frequently repeated, the various diseases that are likely to develop in the cervix, as well as certain surgical procedures, are all capable of producing such obstruction and may result in the accumulation of blood or menstrual fluid within the uterus.

The part or parts of the genital tract in which the accumulation occurs are determined by the site, duration, and extent of the obstruction, and the rapidity with which the fluid accumulates. If the obstruction is near the outlet of the vagina and a considerable portion of the vaginal cavity is patent above it, the ready distensibility of this portion of the genital tract will accommodate a large quantity of fluid and lead to the formation of marked primary hæmatocolpos before the uterus becomes involved (Fig. 1a). When the pressure is increased sufficiently to distend the thicker and more muscular walls of the uterus, hæmatometra results secondarily (Fig. 1b). When, however, only a small portion of the vagina remains patent above the obstruction, the fluid is early forced into the uterus and hæmatometra results. If the vagina is completely obliterated, or if the obstruction is in the cervical canal, hæmatometra is primary and there is no hæmatocolpos. In any case hæmatosalpinx on one or both sides may be secondary to hæmatometra (Fig. 1c), and if the outlet of the fallopian tubes is patent and pressure is sufficient, leakage may occur into the peritoneal cavity to form hæmoperitoneum.

In animals a collection of transudate or other sterile fluid may accumulate in the uterus as a result of congenital or acquired obstruction (14), but we have been unable to find a reported instance in which retention of blood has occurred. According to Brumley, obstruction to the outlet of the uterus may develop in animals as the result of injuries arising during parturition, from the pressure of inguinal hernia, or following ligation of the uterus which is sometimes done to prevent conception. In animals, however, with the possible exception of some of the higher apes, menstruation does not occur, and the only way in which hæmatometra could develop, even in the presence of obstruction, would be as the result of bleeding from a retained placenta or from degenerating uterine neoplasm.

[1] Abridgment of thesis submitted to the Faculty of the Graduate School of the University of Minnesota in partial fulfillment of the requirements for the degree of Master of Science in Surgery, 1927.

Most of the reported cases of hæmatometra are of congenital origin. Among the earliest cases in this group is that of Chegoin, in 1829. The patient was a married woman, aged 32, in whom hæmatometra had developed as the result of a congenitally imperforate uterus and absence of the cervix. In the same year Dance reported a case of hæmatometra which had followed difficult and premature delivery. He stated that, while it is not unusual for retention to result from congenital malformations, he was unable to find another instance reported in which it had developed following labor. Both of these cases were successfully treated by puncture.

Bernutz, in 1848, reviewed from the literature a number of cases of hæmatometra, and proposed a classification on an etiological basis into four groups: (1) congenital; (2) following labor; (3) a reflex type comparable to cystitis with retention; and (4) retention resulting from emotional states such as shock and anger. He was the first to recognize that complete obstruction is not essential for the production of hæmatometra.

Dubrueil's case, reported in 1889, was of interest, because hæmatometra developed after the menopause had been passed. The origin of the bleeding was not proved but fibromyoma was suspected.

A number of cases have been reported in the literature since 1900, and more attention has been given to the problems of treatment. Horrocks, in discussing treatment, condemned the indiscriminate use of the puncture method, which he believed to be applicable only in cases in which hæmatocolpos alone was present.

Quénu and Le Sourd, in 1906, reviewed from the literature 8 cases of uterus didelphys complicated by hæmatometra. Six of these had been treated by conservative operations, consisting either of drainage through the vagina, usually combined with abdominal exploration, or of hemihysterectomy. These authors emphasized the importance of abdominal exploration at the time of vaginal drainage to guard against the danger of rupture of adherent hæmatosalpinx, should the sudden loss of fluid from the uterus cause it to contract rapidly and extensively. They also pointed out that in a uterus didelphys, menstruation may occur normally on one side coincident with the development of hæmatometra on the opposite side. In one instance pregnancy had occurred in the unobstructed portion of such a uterus. While they were not able to find any record of pregnancy following conservative operation on uterus didelphys they believed it to be theoretically possible.

In 1907 Sikora, in discussing the treatment of hæmatometra, called attention to the fact that the methods of treatment had varied from time to time, but that there had been a progressive tendency toward the use of more radical surgical measures. He concluded that conservative measures should be employed whenever possible, whether the uterus is single or double, but that when the uterus is diseased it should be removed.

Andrews, in 1911, reported two cases of hæmatometra complicated by hæmoperitoneum. He had noted two similar cases in the literature.

Gellhorn, in reporting an instance of hæmatocolpos, hæmatometra, and hæmatosalpinx secondary to gynatresia in a case in which the menopause had long since been passed called attention to the small number of similar cases reported in the literature. He concluded that the most common cause of gynatresia in the aged is a senile adhesive process secondary to senile vaginitis. As a result of this process which is really a thinning of the squamous epithelium of the vagina, a raw surface is created, the lumen of the vagina is narrowed as a result of changes in its elastic fibers, and, when the walls approximate, bands and constrictions develop. This type of obstruction he believed is most likely to occur at the juncture of the middle and upper third of the vagina because of the narrowing produced at that point by the levator ani muscles. The source of the bleeding in these cases is usually from a tumor.

Cases of various types and etiology have been reported by Gutiérrez, Eising, Purslow, Jones, and others (1, 7, 11, 18, 20, 24, 28).

CASES FROM THE MAYO CLINIC

Twenty-three cases of hæmatometra, all but one of which were verified at operation,

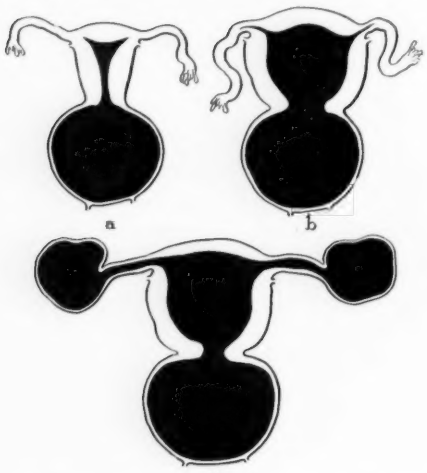

Fig. 1. The sequence of involvement of the female genital tract with retention of menstrual fluid following low vaginal obstruction: a, hæmatocolpos; b, hæmatocolpos and hæmatometra; c, hæmatocolpos, hæmatometra, and bilateral hæmatosalpinx.

were observed at the Mayo Clinic from 1912 to 1926 inclusive. In 11 of these the obstruction was congenital and in 12 it was acquired (Tables I and II).

CONGENITAL TYPE OF OBSTRUCTION

Etiology. Embryologically, according to Piersol, the uterus develops from the muellerian ducts which unite at about the eighth week of intra-uterine life. After the union of these ducts, the intervening septum disappears and a single tube is formed, the anlage of the uterus. This ends blindly and is joined to the urogenital sinus by a solid cylinder of cells. This lumenless segment of the fused muellerian ducts represents the anlage of the vagina. By the end of the fourth month of intra-uterine life, it too has normally acquired a lumen and the anlage of the cervix has made its appearance at the uterovaginal juncture.

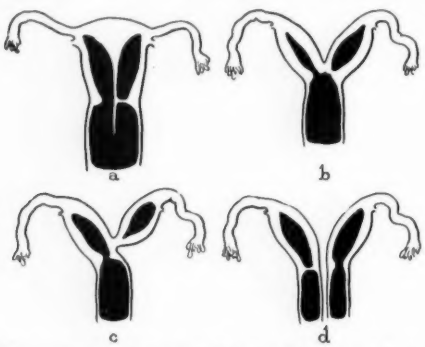

Fig. 3. Some of the possible combinations of simple obstructive anomalies with the more common types of duplication: a, persistent septum with atresia of the cervix on one side; b, uterus bicornis with atresia of the cervix on one side (two cervices); c, uterus bicornis with obstructed rudimentary horn; and d, uterus didelphys with atresia of the cervix on one side.

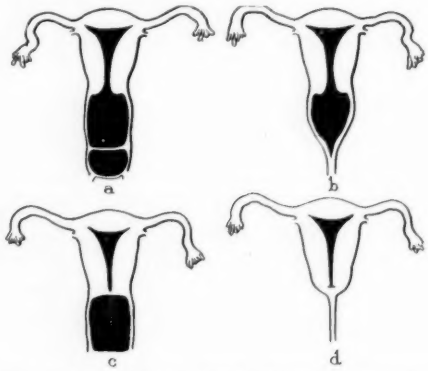

Fig. 2. Some of the simple obstructive congenital anomalies of the vagina: a, imperforate hymen or persistent membrane above the hymen; b, partial atresia of the vagina; c, atresia of the cervix; and d, complete atresia of the vagina.

The chief anomalous conditions of the uterus and vagina depend on defective or incomplete development or imperfect fusion of the two muellerian ducts. Arrested development of the lower part of these fetal canals accounts for the absence of all or any part of the cervix or vagina or the persistence of a membrane obstructing their lumen at any point. Depending on the extent to which failure of fusion occurs, all degrees of duplication may result. Duplication and obliteration of different portions of the genital tract may co-exist in numerous combinations.

In order that hæmatometra or hæmatocolpos may develop as a result of congenital anomalies, two conditions must be fulfilled: the uterus must be sufficiently well developed to perform the function of menstruation, and the anomaly must include some type of obstruction which prevents the escape of these

Fig. 4. Case 7. Cross section of uterus with hæmatometra, from congenital atresia of the vagina and stenosis of the external os.

menstrual products. Figures 2 and 3 illustrate some of the more common anomalies or combinations of anomalies in which these conditions are fulfilled.

The most common type of obstruction is an imperforate hymen or the persistence of a membrane across the vagina a short distance above the hymen (Fig. 2a). Almost as often, varying portions of the vagina may remain obliterated, the atresia usually beginning at or just beyond the introitus and extending upward, leaving only a shallow pit of a few centimeters to mark the site of the vagina externally (Figs. 2b and 2d). If the entire vagina is absent, the cervix may also be absent and the uterus attached in the pelvis by a fibrous cord. Occasionally the vagina may develop normally while the cervix is absent or there is atresia of the cervical canal (Fig. 2c). In a uterus didelphys or a uterus bicornis, obstruction may be present on one or both sides in any position for which it has been described in the single uterus (Figs. 3, a, b, c, and d).

In 11 of the 23 cases in this series, the obstruction was of the congenital type, and in 9 of these the anomaly depended on varying degrees of arrested development of the vagina (Tables 1, A and 1, B). In one there

Fig. 5. Case 8. Hæmatometra and bilateral hæmatosalpinx from congenital atresia of the vagina.

was an imperforate hymen; in two a diaphragm persisted across the vagina above the hymen, and in 6 there were varying degrees of vaginal atresia (Figs. 4 and 5). In two instances the anomalies were more complex (Table 1, C). The patient in Case 10, aged 17 years, had menstruated regularly since the age of 13, but she had suffered severe attacks of lower abdominal pain, especially marked on the right side and sometimes associated with the menstrual periods. Pain was becoming progressively more severe and recently had been associated with vomiting and hallucinations. There was incomplete uterus didelphys (Fig. 6), in the left side of which was a normal outlet that had been responsible for the menstrual flow. The outlet in the right side, however, was occluded and hæmatometra had developed.

One case of true hermaphrodism, Case 11, is included in the series.[1] In this patient there was a uterus didelphys (Fig. 7) which communicated through the small vagina with the posterior male urethra at the verumontanum. The communication was so small, however, that it offered partial obstruction to the escape of menstrual fluid and caused a hæmatometra and a bilateral hæmatosalpinx. The symptoms were typical of hæmatometra, but because of the communication with the posterior urethra there was, also, periodic hæmaturia associated with each attack of pain.

Symptoms. If there is congenital obstruction in the vagina uncomplicated by other

[1] This case was reported in detail by Masson in 1925.

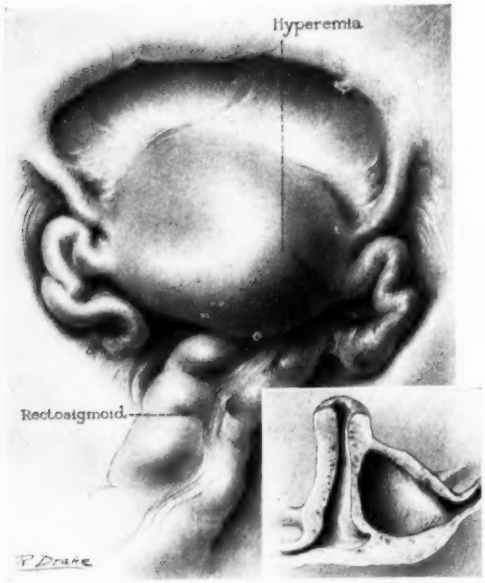

Fig. 6. Case 10. Uterus bilocularis unicollis. Atresia at the level of the internal os on the right side with hæmatometra.

anomalies, the patient gives a history of complete absence of menstruation, with the onset, just prior to or at puberty, of monthly attacks of pain and cramps in the pelvis and lower part of the back. The pain at first is moderately severe, but with succeeding attacks it becomes more severe and of longer duration. The intervals between the attacks are thereby shortened until the pain is almost continuous and frequently almost unbearable. Nausea and vomiting and varying degrees of prostration are sometimes present. Before puberty, quantities of mucous secretion may collect and distend the genital tract above such an obstruction, thus producing mild symptoms, but with the onset of puberty these secretions are rapidly augmented and replaced by the products of menstruation and the symptoms soon become more severe.

The patient is often aware of a tender mass in the pelvis or in the lower part of the abdomen, and the history is frequently given of enlargement of this tumor coincident with the onset of each attack of pain. The mass may decrease in size somewhat after each individual attack but it does not return to its previous dimensions before the succeeding attack intervenes. In the presence of hæmatocolpos, the pressure of this mass on the bladder may give rise to a moderate degree of frequency and burning on urination and occasionally to complete urinary retention (9, 21).

More complex anomalies may modify the symptoms accordingly. When there is duplication of the uterus with obstruction of the outlet of one side only, menstruation occurs regularly or the patient may become pregnant coincident with the development of hæmatometra on the other side.

THE ACQUIRED TYPE OF OBSTRUCTION

Etiology. The acquired type of obstruction is almost always in some portion of the cervical canal and is consequently not associated with hæmatocolpos. The obstruction usually follows either severe lacerations from miscarriage or difficult labor, or it is a direct result of a plastic operation on the cervix. Other occasional etiological agents that have been reported are the wearing of a stem pessary over a long period of time (16), the application of radium to the cervix (17), fibromyomata obstructing the lumen of the cervical canal (27), and adhesions between the cervix and the wall of the vagina. Only rarely has cauterization alone of the cervix resulted in obstruction. In Case 15 (Table II), the obstruction followed the use of the cautery but was combined, however, with dilatation and curettage and removal of a specimen from the cervix for biopsy. In this instance, the use of the cautery alone cannot be considered the etiological factor. In the aged as was pointed out by Gellhorn, senile vaginitis may occasionally lead to the formation of obstruction in the vagina. As these patients have usually passed the menopause, hæmatometra, and hæmatocolpos result only in some pathological process, such as tumor, which is producing bleeding.

In the congenital type, the obstruction is almost always complete from the beginning, but in the acquired type there is not infrequently a period during which the occlusion is only partial. The obstruction may quickly become complete or it may remain indefinitely as an incomplete type.

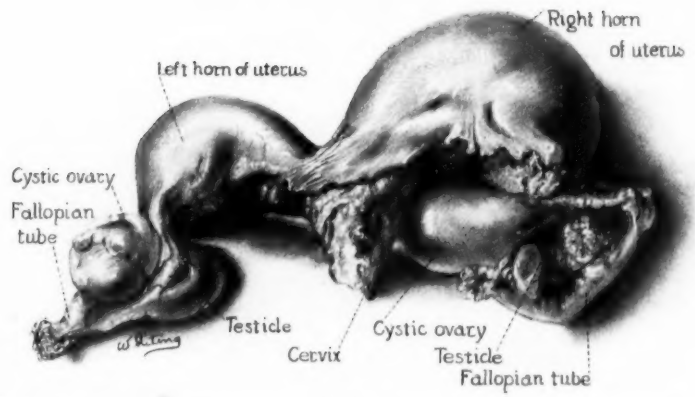

Fig. 7. Case 11. Hæmatometra in a uterus didelphys from a case of true bilateral hermaphrodism.

Twelve of the 23 cases in the series resulted from an acquired type of obstruction and 5 of these followed some type of plastic operation on the cervix (Table II, A). In three instances the operation included amputation of the cervix and in two instances it included dilatation and curettage alone and dilatation and curettage combined with biopsy and cauterization of the cervix. In one instance, Case 17, an incomplete type of obstruction followed amputation of the cervix and developed into complete obstruction after the application of radium. In three instances, trauma incident to miscarriage or labor was responsible for the onset (Table II, C). In Case 21 there was slight hæmatometra which had not produced symptoms; it was noted incidentally in a uterus that had been removed for complete prolapse in a patient aged 62 years. Obstruction was the result of a submucous fibromyoma situated at the internal os, combined with the reduction in the size of the lumen of the canal which is part of the normal involutionary process occurring after the menopause. In this case, degenerating fibromyomata in the fundus were responsible for the bleeding. In Cases 22 and 23 the cause of the stenosis was not apparent (Fig. 8).

Symptoms. The age at which symptoms develop in the acquired type of obstruction is considerably greater than that at which they develop in the congenital obstruction, the average age in the former being 36½ years and in the latter puberty. The oldest patient in the series was aged 62. After the menopause, obstruction developing at the cervix produces hydrometra rather than hæmatometra, unless there is bleeding from neoplasm in the fundus or from degenerating submucous fibromyomata, as there was in this instance.

In the acquired types, the patient gives a history of previous menstruation and usually dates the onset of symptoms from the occurrence of some one of the etiological agents mentioned. Since the obstruction is usually at the cervix, hæmatocolpos with its accompanying urinary symptoms is usually absent. The character and periodicity of the pain is similar to that in the congenital type, but it is often less severe because the obstruction at first is likely to be incomplete and because the uterus at this period in life is more completely developed and more readily distensible than at puberty.

If obstruction is incomplete, the small opening which persists acts as a safety valve; the fluid is retained within the uterus until the pressure is sufficient to force it through this opening. Since only a small amount of the fluid can escape at a time while the reserve within the uterus is regularly replenished by the menstrual flow, the result is an intermittent or continuous discharge. This is associated with periodic attacks of pain and enlargement of the uterus typical of the complete type of obstruction. The discharge often

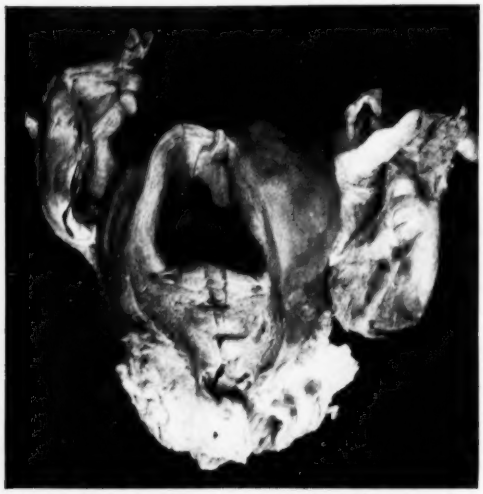

Fig. 8. Case 22. The uterus and adnexa from a patient with hæmatometra from stenosis of the external os. Etiology not definitely established.

acquires an offensive odor, the result of infection.

The general health of the patient remains unimpaired unless the symptoms are of unusual severity or prolonged duration, when there is weakness and loss in weight. If infection develops, there is elevation in temperature and pulse rate and increase in the number of leucocytes.

DIFFERENTIAL DIAGNOSIS

Dysmenorrhœa from other causes, but especially the idiopathic type, may be confused with hæmatometra. In no instance should hæmatometra be diagnosed unless definite obstruction can be demonstrated in some portion of the lower part of the genital tract, and unless enlargement of the uterus can be demonstrated either persistently or intermittently in association with the attacks of pain. It is further essential for a diagnosis of hæmatometra that the retention of an appreciable amount of blood within the uterus be demonstrated at the time of operation.

TREATMENT

The earlier cases reported were treated rather indiscriminately by vaginal drainage, a trochar being used. The drainage was often inadequate and recurrence was frequent. Furthermore incomplete and often prolonged drainage not infrequently resulted in ascending infection of uterus and fallopian tubes, and sometimes extension into the peritoneal cavity with the development of fatal peritonitis. It then gradually came to be recognized that this method of treatment was only applicable in certain types of cases and that in many instances more radical measures were not only necessary to accomplish a cure, but safer.

In young patients especially, it is desirable, if possible, to employ conservative measures in dealing with the pelvic organs. Unfortunately, in the younger patients with hæmatometra the obstruction is practically always congenital frequently involving a large part of the vagina, or is associated with other anomalies which make conservative treatment difficult or impractical.

In uncomplicated cases of hæmatocolpos, with or without hæmatometra, in which the obstruction is due to imperforate hymen or persistent membrane across the vagina, free incision with irrigation of the cavities is the treatment of choice. In the uncomplicated cases which result from subtotal congenital atresia in which the uterus and cervix have developed normally and are attached to the vagina, the drainage operation is also applicable. If conservative treatment fails, if infection is present, or if the uterus and cervix have not developed normally or are attached to the vagina by a fibrous cord only, hysterectomy should be performed, and later in life, should it be indicated, a plastic operation can be performed to make a vagina.

In the presence of hæmatosalpinx on one or both sides, conservative treatment by vaginal drainage is attended by added risk because of the danger of rupture of the tube, if it is anchored by adhesions. As was pointed out by Carville and others, in contracting down when thus rapidly emptied, the uterus may produce sufficient traction on the distended and anchored tube to rupture it. Furthermore, the incidence and seriousness of secondary infection is increased in the presence of hæmatosalpinx because the distended and often dependent tube may not empty com-

TABLE I.—HÆMATOCOLPOS, HÆMATOMETRA AND HÆMATOSALPINX RESULTING FROM CONGENITAL TYPES OF OBSTRUCTION[1]

Case	Age	History	Clinical data	Treatment	Results	Comment
A. Congenital septum or imperforate hymen						
1	16	Never menstruated; monthly attacks of severe backache and abdominal cramps, with urinary frequency; abdomen enlarging and tender; duration, 3 years	Bulging, imperforate hymen; pelvis filled by cystic mass; hæmatometra and hæmatocolpos	Hymen freely incised; 1250 c.cm. bloody fluid released; uterus irrigated and packed with iodoform gauze	Convalescence uneventful; 6 years later in good health and menstruating regularly	
2	14	Never menstruated; monthly attacks of bearing-down pain in the pelvis becoming progressively more severe; moderate dysuria and frequency; duration 1 year	Diaphragm across vagina 2.5 cm. above hymen, cystic mass in pelvis; temperature 100°	Incision of membrane followed by infection; 3½ weeks later panhysterectomy	Drainage for several weeks, convalescence otherwise uneventful; 6½ years later in good health	Acute inflammation of the uterus, tubes, and ovaries.
3	18	Onset of monthly attacks of pelvic pain at age of 12; vaginal septum incised and menses normal; at 15 pelvic infection developed with persistent profuse discharge	Remnants of vaginal septum with a large tender mass in the pelvis; temperature 103°, general condition poor	Vaginal drainage of large amount of pus; panhysterectomy after 4 months	Recovery, health fair; 2 years later died from pyelonephritis	Extensive inflammation of the uterus and adnexa.
B. Vaginal atresia						
4	15	Never menstruated; monthly attacks of severe abdominal cramps; duration 7 months	Large firm tumor in pelvis, atresia of vagina; hæmatometra	Vaginal drainage of 1000 c.cm. thick chocolate colored fluid; uterus packed with iodoform gauze	Convalescence uneventful; 2 months later menstruation became normal; 6 months later health was good	
5	13	Never menstruated; pain in lower part of back and abdomen with mild irritation of bladder; duration one year; tender mass in pelvis 6 months	Vulva incompletely developed; complete atresia in lower part of vagina; large cystic mass in pelvis and lower part of abdomen	Combined abdominal exploration and drainage by vagina 1000 c.cm. tarry blood	Two months later patient well and had menstruated normally twice; died from peritonitis 3½ years later	Anomolies of the genitalia were present in several other members of the family.
6	16	Never menstruated; monthly attacks of severe cramps in lower part of abdomen, vomiting; mild frequency and dysuria at times, duration 2 years; several previous unsuccessful attempts to open vagina	Defects of labia and atresia of vagina; uterus enlarged with cystic masses on both sides	Panhysterectomy	Convalescence uneventful; 7 years later in best of health and happily married	Hæmatometra with bilateral hæmatosalpinx; ovaries cystic and atrophic.
7	21	Never menstruated; monthly attacks severe abdominal cramps; two previous unsuccessful attempts to open vagina; duration 6 years	Vaginal atresia; uterus not connected with rudimentary vagina	Hysterectomy; bilateral salpingectomy	Convalescence was uneventful; 10 months later the patient was in good health	Hæmatometra and left hæmatosalpinx; external os stenosed and cervical canal dilated.
8	12	Never menstruated; monthly attacks of severe abdominal pain progressively more severe; duration 9 months	Vagina patent external 4 cm. only; uterus enlarged and not connected with rudimentary vagina; tender masses on both sides	Hysterectomy and bilateral salpingectomy	Convalescence uneventful	Stenosis of internal os with hæmatometra and bilateral hæmatosalpinx.
9	18	Never menstruated; monthly attacks of low abdominal cramps; nausea and vomiting recently; duration 5 months	Imperforate hymen; atresia of vagina; small mass in left side of pelvis and larger cystic mass on right side; cervix absent	Hysterectomy	Convalescence uneventful	Uterus bicornis with rudimentary horn on the left; small hæmatometra on right; hæmatosalpinx.
C. Miscellaneous group						
10	17	Onset of menstruation at the age of 13; severe attacks of pain usually associated with menses, and worse on right side; progressively more severe with vomiting and hallucinations	Cervix small; fundus indistinguishable from large round mass in pelvis	Plastic operation; right horn removed with the right tube and ovary; left uterine cavity communicated with vagina	Convalescence uneventful; 3 months later in good health and menstruating normally	Incomplete uterus didelphys left side normal; hæmatometra on right side.
11	40	Recurrent attacks hæmaturia with frequency and pain in the left side; duration 10 years	Bilateral undescended testis; some female characteristics but known as a male; penis normal; prostate absent; pelvic mass; blood entered urethra on cystoscopic examination	Panhysterectomy; right kidney absent, the left enlarged	Convalescence uneventful; well 3 years later	Normally developed tubes and ovaries uterus didelphys both horns dilated with menstrual blood.

[1] All the patients in this group were unmarried.

TABLE II.—HÆMATOMETRA AND HÆMATOSALPINX FROM ACQUIRED TYPES OF OBSTRUCTION[1]

Case	Age	History	Clinical data	Treatment	Results	Comment
A. Following plastic operation						
12	30	One child, difficult delivery; plastic on cervix 4 years previously with cessation of menses and onset of monthly attacks of abdominal cramps, progressively more severe (married 6 years)	Uterus enlarged to twice normal size; soft masses both sides; cervix amputated flush; no os demonstrable	Hysterectomy and bilateral salpingectomy with partial resection of ovaries	Convalescence uneventful	Os completely occluded by a septum; hæmatometra and bilateral salpingitis, granular and hæmorragic endometritis
13	30	Severely lacerated at childbirth 12 years previously; perineorrhaphy and cervix amputated; recently dysmenorrhœa; menses irregular and absent at times	Cervix cystic and scarred; canal almost completely obliterated; uterus enlarged and soft	Dilatation and curettage; small amount of old blood retained in uterus	Convalescence uneventful	Incomplete type of obstruction.
14	45	One child; since amputation of cervix 4 years previously menses irregular; occasional amenorrhœa with enlargement of uterus, some intermenstrual spotting with foul odor (married 20 years)	Uterus twice normal size; incomplete stenosis of cervix	Cervix dilated; about 200 c.cm. old blood escaped; uterus irrigated and packed	Typhoid fever developed during convalescence; 3½ years later free from symptoms	Incomplete type of obstruction.
15	53	Four children and several miscarriages; 6 months previously, dilatation and curettage, biopsy and cauterization of cervix followed by monthly attacks of very severe pelvic cramps; amenorrhœa; spontaneous rupture and escape 1500 c.cm. old blood during an attack 5 days previously	Uterus retroflexed, tender and enlarged; external os closed	Subtotal hysterectomy	Convalescence uneventful	Uterus dilated, endometrium markedly hæmorrhagic and hypertrophic with sclerosis of vessels.
16	40	Eight children, last one 18 months previously followed by profuse bleeding; then dilatation and curettage; amenorrhœa since with monthly attacks of severe pain (married 13 years)	Firm irregular pelvic mass	Hysterectomy with removal of both tubes and ovaries	Convalescence uneventful, recent case	Uterus dilated with old blood; chronic salpingitis; ovarian and parovarian cysts.
B. Following radium						
17	36	Amputation of cervix 3 years previously; radium to cervix 1 year previously followed by severe attacks of right lumbar pain; amenorrhœa after first three attacks; almost constant pain	Uterus enlarged and boggy; walked with a slight limp favoring right side	Combined abdominal exploration and drainage of 1000 c.cm. thick black fluid through vagina	Convalescence uneventful; relief from symptoms; hysterectomy elsewhere following return of symptoms	Complete obstruction at cervix.
C. Following accidents incident to labor						
18	43	Seven children, two miscarriages; following miscarriage 1 year previously, monthly attacks of severe pain with moderate enlargement of lower part of abdomen; complete amenorrhœa	Temperature 100.3°, colostrum in breasts; uterus enlarged and firm, no os demonstrated	Combined abdominal exploration and drainage of about 3000 c.cm. chocolate colored fluid through vagina	Convalescence uneventful	Microscopic examination showed fluid containing mucus, blood, and an occasional pus cell.
19	51	Two children, abortion 12 years previously followed by severe dysmenorrhœa; amenorrhœa for 4 years	Uterus enlarged with a cyst on left side; cervix stenosed	Hysterectomy and removal of inflammatory cyst from left side; removal of right adnexa	Convalescence uneventful	Cervical stenosis, atrophic endometrium; chronic right salpingitis.
20	38	First pregnancy 6 years previously; instrumental delivery followed by infection; since then periods of amenorrhœa (married 7 years)	Cervix scarred; almost complete stenosis of external os; uterus enlarged to three times normal size	Dilatation advised	No further record	
D. Miscellaneous group						
21	62	Three children; menopause at 50; no symptoms other than of uterine prolapse	Complete uterine prolapse	Mayo vaginal hysterectomy	Convalescence uneventful	Involutionary stenosis cervical canal; internal os occluded by submucous fibromyoma; fibromyomata in fundus; uterus contained old blood.

TABLE II.—Continued.

Case	Age	History	Clinical data	Treatment	Results	Comment
22	20	Menses normal for 2 years; at 16 menses scanty; then absent with severe backache and bearing-down pain relieved several times by free flow of old blood; abdominal operation for retroversion at 19	Syphilis, later aplastic anæmia; uterus enlarged	None	Died from severe cellulitis of arm	Cervical canal stenosed; uterus dilated with blood; hæmatoma in wall of uterus and hæmorrhage into other viscera.
23	58	Menstruation normal to the age of 40; then no record; dementia præcox since age of 30; later carcinoma of thyroid developed	Necropsy	None	Died from carcinoma of the thyroid	Occlusion of external os; uterus dilated and filled with old blood.

[1] All the patients in this group were married except in Cases 22 and 23.

pletely and, as a source of prolonged drainage into the uterus and vagina, remain as an open pathway by which infection may enter the peritoneal cavity. In the presence of hæmatosalpinx, therefore, and if the exact degree of development of the organs is not evident or if their exact relationship cannot be accurately determined beforehand, abdominal exploration should first be performed in order to determine the feasibility of vaginal drainage.

More complex anomalies offer individual problems in treatment. Uterus didelphys is probably the most amenable of these anomalies to plastic surgery, and when one side of the uterus is normal, resection of the obstructed portion offers a good prognosis from the standpoint of the preservation of the menstrual function and the possibility of future pregnancy. This type of operation is attended by small operative risk. In the one case of hermaphrodism in the series, complete hysterectomy offered the only choice of treatment.

In the acquired type of obstruction, the principles involved in the treatment are the same, except that radical operation may be more readily employed when the patient is approaching the menopause. As a rule, if hæmatometra is slight and uncomplicated, and especially if the obstruction is of the incomplete type, dilatation of the stenosis suffices.

In selected cases, following drainage of the uterus in this manner, chemical hysterectomy as described by Masson and Foucar, would insure against recurrence and eliminate any associated intra-uterine infection. This procedure is especially applicable if patients are near the menopause, or if there is persistent discharge, provided, however, there is no involvement of the fallopian tubes. The uterus must first be returned as nearly as possible to normal size. If involution does not take place spontaneously after drainage, it may be aided by the use of ergot and hot irrigations.

PROGNOSIS

If hæmatometra is allowed to go untreated, a huge accumulation of fluid may result. According to Frank, more than 3.5 liters have been recovered, although the amount usually present varies from a few hundred cubic centimeters to 1.5 liters. With such an accumulation, the pressure may become so great that spontaneous rupture occurs at the weakest point, often the site of the obstruction. However, the opening soon closes and there is either recurrence of the hæmatometra, or pyometra develops. Spontaneous rupture occurred in Case 15 in the series, and this complication has been reported by various observers. In some instances rupture has taken place into the rectum, the bladder, or the labia, while in other instances the fluid has found an outlet into the peritoneal cavity through the fimbriated ends of the fallopian tubes.

In general it is true that the prognosis improves as the surgical treatment becomes more radical. In selected, uncomplicated cases, however, the conservative type of treatment is followed by excellent results as to general health and the continuance of menstrual function.

The possibility of pregnancy occurring after hæmatometra remains questionable. Subsequent pregnancy has not been observed in any of the patients in this series, and we have

not been able to find any case reported in the literature in which it has occurred. It seems probable, however, that subsequent pregnancy should occur in cases in which the uterus is returned to its normal condition prior to the menopause and in the absence of prohibitive congenital malformations.

GENERAL DISCUSSION

The fluid contained within these cavities varies somewhat in character, depending on the age of the patient and the site of the obstruction. If the obstruction is at the outlet of the uterus, the retained fluid consists of the products of menstruation. In congenital atresia, before puberty, mucus may sometimes accumulate in large amounts. After the menopause, if the accumulation of blood is the result of some disease process within the uterus, pure blood mixed with débris in some instances will constitute the retained fluid.

If obstruction is in the vagina, the cervical and vaginal glands contribute their secretions.

Prior to operative interference, the fluid is usually sterile. Bell studied the chemical composition of hæmatocolpos fluid from two cases and found that the calcium content was high but that fibrin ferments and fibrinogen were lacking.

SUMMARY

Hæmatocolpos, hæmatometra, and hæmatosalpinx may develop as the result of obstruction within the lower part of the female genital tract, thus preventing the normal escape of the menstrual products or blood from the uterus. Such obstruction may be congenital in origin; it then usually involves the vagina and may be simple or associated with more complex anomalies of the genital tract. In other instances it may be acquired, in which case it usually involves the cervix, except in the aged, and is frequently the result of trauma incident to parturition or follows plastic operations on the cervix. The acquired type of obstruction may be complete or incomplete.

The symptoms are typical. There is absence or cessation of the menses, coincident with the appearance of attacks of severe pelvic or abdominal cramps usually occurring about once a month. These attacks of pain tend to become progressively more severe and are associated with progressive enlargement of the uterus.

The treatment varies with the individual case. The genital organs should be preserved during the childbearing age, when the risk of the conservative type of operation is not prohibitive. In the presence of certain complications, vaginal drainage should be combined with abdominal exploration. In certain cases radical surgical measures should be adopted primarily.

BIBLIOGRAPHY

1. Andrews, H. R. A clinical lecture on retention of menses. Clin. J., 1909, xxxv, 61–64.
2. Idem. Two cases of retention of menses in which the peritoneal cavity contained free blood. J. Obst. & Gynæc., Brit. Emp., 1911, xix, 521–524.
3. Bell, W. B. The nature of hæmatocolpos fluid with deduction as to the chemical composition of the menstrual discharge and the cause of the normal non-coagulability, also of the acidity of the vaginal secretion; and the character of the obstructing membrane with its bearing on the development of the vagina; together with a report of three cases of hæmatocolpos. Proc. Roy. Soc. Med.; Obst. and Gynec. Sect., 1911, iv, part ii, 234–244.
4. Bernutz, G. Mémoire sur les accidents produits par la rétention du flux menstruel. Arch. gén. de méd., 1848, lxxvii, 129–152; 433–465; lxxviii, 405–431.
5. Brumley, O. V. Diseases of Small Domestic Animals. New York: Lea and Febiger, 1921, 672 pp.
6. Carville. Imperforation du vagin; aménorrhée. Hématocèle considérable. Opération. Rupture des trompes. Mort par peritonite latente. Bull. et mém. Soc. anat. de Par., 1867, xlii, 306–310.
7. Champel. Malformation génitale (utérus biloculaire avec hematométrie unilaterale) chez une jeune fille. Lyon méd., 1921, cxxx, 1082–1086.
8. de Chégoin, Hervey. Imperforation de l'uterus. Abstracted in Arch. gén. de méd., 1829, xxi, 610–612.
9. Cowen, Ingham. A case of retained menses. Practitioner, 1911, i, 724.
10. Dance. Observations sur plusieurs affections de l'utérus et de ses annexes. Arch. gén. de méd., 1829, xx, 521–550.
11. Décès. Utérus et vagin double. Arrêt de la menstruation. Bull. et mém. Soc. anat. de Par., 1854, xxix, 222–232.
12. Dubrueil, A. Hématométrie. Rev. de chir., 1889, ix, 677–682.
13. Eising, E. H. Absence of vagina; unilateral development of internal genital organs; hæmatometra. J. Am. M. Ass., 1921, lxxvi, 31–32.
14. Fox, Herbert. Disease in Captive Wild Mammals and Birds. Philadelphia: J. B. Lippincott Co., 1923, 665 pp.
15. Frank, R. T. Gynecological and Obstetrical Pathology. New York: D. Appleton and Co., 1922, 536 pp.

16. Gardner, William. A case of hæmatometra. Montreal M. J., 1900, xxix, 57–58.
17. Gellhorn, George. Hæmatocolpos, hæmatometra, and hæmatosalpinx in a woman of seventy-four years. Surg., Gynec. & Obst., 1917, xxiv, 37–42.
18. Idem. Hæmatometra due to radium. Surg. Clin. N. Amer., 1922, ii, 1707–1708.
19. Goullioud, M. Menstruation et aménorrhée douloureuses par malformation utérine. Lyon chir., 1909, ii, 229–237.
20. Gutiérrez, A. Hæmatometra and appendicitis. Abstracted: J. Am. M. Ass., 1921, lxxvi, 1619.
21. Harthill, J. T. A case of retained menses relieved by operation. Brit. M. J., 1910, i, 71–76.
22. Haworth, J. K. Retention of urine due to hæmatocolpos and hæmatometra in a child. Brit. M. J., 1921, i, 673.
23. Horrocks, Peter. A case of concealed menstruation; with remarks on treatment. Lancet, 1905, i, 1247–1250.
24. Jones, W. C. Report of a case of hæmatometra. New Orleans M. & S. J., 1925, lxxviii, 95–96.
25. Maclean, Ewen. Dysmenorrhœa; hæmatometra of one horn of uterus bicornis. J. Obst. & Gynæc., Brit. Emp., 1911, xx, 18–19.
26. Masson, J. C. A case of true hermaphrodism. Am. J. Obst. & Gynec., 1925, ix, 81–86.
27. Masson, J. C., and Foucar, H. O. The use of zinc chloride in gynecology. Am. J. Obst. & Gynec., 1925, x, 355–364.
28. Meredith, W. A. A case of hæmatometra associated with a degenerating fibromyoma, treated by supravaginal hysterectomy. Tr. Obst. Soc. London, 1888, xxix, 422–428.
29. Mondy, S. L. C. Retained menses in a child of fourteen and a half years. Edinburgh M. J., 1910, iv, 541–542.
30. Oldham, H. Sur la dysménorrhée. London M. Gaz., 1846, iii, 919–970. Abstracted: Arch. gén. de méd., 1847, lxxiv, 371–375.
31. Piersol, G. A. Human Anatomy. Philadelphia: J. B. Lippincott Co., 1913, ii, 2010–2012.
32. Purslow, C. E. A case of unilateral hæmatocolpos, hæmatometra and hæmatosalpinx. J. Obst. & Gynæc., Brit. Emp., 1922, xxix, 643.
33. Quénu and Le Sourd, Étienne. Des opérations conservatrices dans le traitement des utérus didelphes à corps independants. Rev. de chir., 1906, xxxiii, 1.
34. Sikora, Pierre. Indications et procédés opératoires dans le traitement de l'hématométrie. Presse méd., 1907, xv, 505–506.
55. Stark, J. N. Acute torsion of normal appendages with hæmatosalpinx. J. Obst. & Gynæc., Brit. Emp., 1911, xix, 258–260.

CLINICAL SURGERY

FROM THE SURGICAL CLINIC OF PROFESSOR V. HABERER

THE BILLROTH I RESECTION OF THE STOMACH[1]

By Dr. VICTOR ORATOR,[2] Duesseldorf, Germany
Formerly First Assistant in the Clinic of Professor V. Haberer

ALTHOUGH the etiology of stomach or duodenal ulcers is still not definitely established, Professor Haberer's practical experiences, which began when he was an assistant in von Eiselsberg's clinic, together with the teachings of modern research, have established one fact, namely, that resection of the ulcer together with the pyloric third of the stomach is essential for permanent cure (9, 10, 16). We may, therefore, choose either the Billroth I or the Billroth II operation.

Since 1919, Hofrat von Haberer has considered the Billroth I the operation of choice and has used this method in 1,300 of his last 2,000 resections of the stomach. It is only through the use of the Billroth I operation that the best physiologico-anatomical relations are re-established. The most successful immediate and late results are obtained from this operation which is the shortest one to perform. Moreover, pepticojejunal ulcers occasionally follow the Billroth II operation and are so common after gastro-enterostomy and pyloric exclusion that that type of operation has had to be abandoned.

INDICATIONS FOR OPERATION

Gastric ulcers. All chronic, calloused, stomach and duodenal ulcers which medical treatment has failed to cure permanently, should be resected. Practically every diagnosis of chronic calloused ulcer in our clinic has been confirmed by X-ray by Dr. Leb, of the Zentral-Roentgen Institut. He has specialized in X-ray of the stomach and duodenum so that he can visualize and localize ulcer niches as small as millet seeds.

All acute, non-calloused ulcers are treated medically.

Ulcer complications. Perforated ulcers are resected if possible, and if the patient's condition will permit it. When resection is impossible, the ulcers are simply sutured over and jejunostomy added if needed. The peritoneal cavity is sponged out and closed without drainage (1 and 17).

Surgery is delayed in cases with acute ulcer hæmorrhage and if indicated transfusion administered.

Blood transfusion together with glucose and insulin administered intravenously is indicated before operative treatment in patients exsanguinated from chronic ulcer hæmorrhage.

Inasmuch as all chronic calloused ulcers are resected in von Haberer's clinic, their malignant degeneration which is estimated at about 6 per cent (7) (for prepyloric as high as 30 per cent) (15) need not be considered.

Pepticojejunal ulcers, which cannot always be confirmed roentgenologically, are a definite operative indication. Even in these cases after radical resection, the Billroth I operation should be used if possible because there is an ulcer predisposition and in occasional cases a pepticojejunal ulcer will recur. In these cases, it is of great importance to include the pylorus in the resection because a similar condition to pyloric exclusion is otherwise established (5, 6, 9).

After a gastro-enterostomy, many cases without pepticojejunal ulcers still have symptoms if the original ulcer is not healed, and require another laparotomy. In these cases a Billroth I is done after the gastro-enterostomy has been separated.

Neoplasm of the stomach. The Billroth I anastomosis is as a rule used after the most radical resection for carcinoma. The duodenum is generally not involved by the carcinoma and even with a subtotal stomach resection the Billroth I can be completed easily. The rapidity with which this operation can be finished is of great value to the cachectic carcinoma patient. As there is

[2] When the editors of Surgery, Gynecology and Obstetrics invited Prof. von Haberer to describe the technique of the Billroth I stomach resection used in his clinic, he asked me to write the article. This description naturally resembles the one published by von Haberer himself (2 and 4) in 1920 although since then there have been developed some essential technical improvements. I wish to thank my superior for the trouble he has taken to supervise and approve this description of the technique he uses today.—V. O.

[1] Translated by Samuel Fogelson, M.D., Chicago.

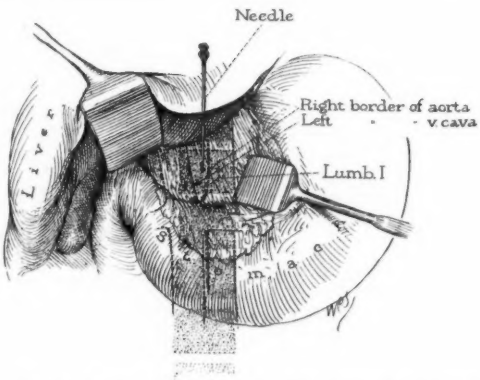

Fig. 1. Splanchnic anæsthesia. Liver retracted upward by the liver retractor. Stomach pulled down. Point of the needle upon the spinal column with the aorta pushed to the right.

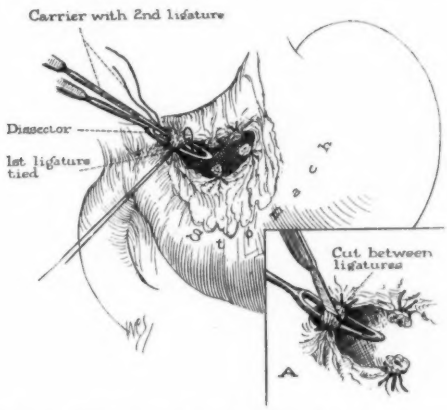

Fig. 2. Ligation of the left gastric artery. Stomach pulled down; lesser omentum split by scalpel; liver pulled upward by retractor; dissector pushed into the slit in the lesser omentum, then out, elevating the left gastric artery; and vessels along the lesser curvatures upon the dissector, ready for ligation.

little danger of postoperative hæmorrhage, the submucosa-hæmostatic sutures may usually be omitted. The serosa must be very exactly sutured because the adhering ability of the peritoneum is markedly reduced in carcinomatous patients. This danger is, however, equally great with the Billroth II operation.

PRE-OPERATIVE PREPARATION

The patient should stay in bed at least 5 or 6 days prior to the operation. Whenever possible symptoms of acute irritation should be allowed to subside. The stomach is emptied the night before the operation and again immediately before the operation by means of an extreme Trendelenburg position which allows complete emptying of the stomach through the stomach tube. Hæmorrhage contra-indicates this procedure, but perforation does not. One hour before the operation, ½ centigram of morphine is given, followed by 1 centigram of morphine and 1 centigram of atropin three-quarters of an hour later.

OPERATIVE TECHNIQUE

1. *Anæsthesia and opening of the abdomen.* Subfascial and subcutaneous infiltration with ¼ per cent tutocain is made along the costal margins and then down to the umbilicus. After the abdomen has been opened, Braun's splanchnic anæsthesia is obtained by injecting 80 to 100 cubic centimeters of ¼ per cent tutocain (14, 19).

Ether anæsthesia is used when especially desired by the patient, or if the patient is young or excitable (3). The most exact hæmostasis is essential in opening the abdominal wall.

2. *Exploration of the case.* The stomach and duodenum are examined carefully but without tissue damage; adhesions of the omentum covering the ulcer are freed by means of sharp scalpel dissection. Finally, the posterior wall of the stomach and duodenum is palpated through incisions in the lesser omentum and the gastrocolic ligament. The pancreas, gall bladder, biliary ducts, and appendix are also examined. All large lymph glands are critically considered.

Orientation in the abdomen may become very difficult because: the lesser omentum may appear as a shrunken, board-like loop; the hepatoduodenal and gastrocolic ligament may be altered by œdema; the head of the pancreas may have markedly swelled lymph-glands. Mobilization of the stomach may be limited further by the frequent penetrations into the pancreas, as found in 31 per cent of our cases (18), or into the liver and anterior abdominal wall. The entire planning of the subsequent operative procedure depends upon clarifying the situation as found in such cases.

3. *Preparation for resection.* The most essential prerequisites for successful ulcer resections are exact hæmostasis and preparation for resection with a minimum of tissue damage. According to Haberer, adequate mobilization is and remains most important. The first part of the duodenum and the pars pylorica of the stomach is resected regardless of whether the ulcer is in the duodenum or the center of the stomach. The Billroth I anastomosis is then made possible when the stom-

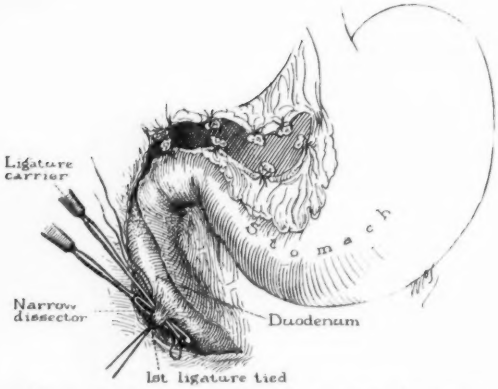

Fig. 3. Freeing of the inferior border of the duodenum. Stomach pulled to the right in order to stretch the duodenum; inferior border of the duodenum mobilized after cutting of adhesions; first ligation of the inferior border of the duodenum.

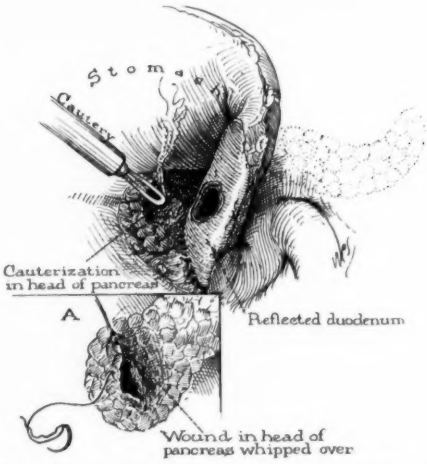

Fig. 4. Cauterization of penetration into the pancreas. *A*. Pancreatic wound partly sutured and peritonized.

ach-duodenum loop is elevated so as to permit approximation of the pars media of the stomach and the first part of the duodenum.

The blood vessels in the lesser omentum and gastrocolic ligament should be ligated with the most careful hæmostasis. The main branches of the curvature vessels are first double ligated at the future line of resection of the stomach and duodenum. This will naturally fall cardial to a stomach ulcer and aboral to one of the duodenum. After ligation of these main vessels, ligation of the remaining vessels in the lesser omentum and gastrocolic ligament can be finished with surprisingly few ligatures.

As a rule, von Haberer begins the dissection where it is the most difficult. In a duodenal ulcer, the duodenum is freed first, and in a gastric ulcer, the stomach. The pars pylorica is the starting place only in the most difficult cases, and then the ulcer is attacked. This type of procedure followed by immediate freeing of the ulcer, accomplishes the desired objective in the most rapid fashion. From our extensive experience, this rapidity makes it the method of choice to be used whenever possible.

The separation of the lesser omentum, gastrocolic ligament, and vascular adhesions, is accomplished by cutting between two interrupted ligatures. These are introduced through blunt aneurism needles guided by Kocher dissectors of the appropriate size, modified by von Haberer. By this technique of multiple interrupted ligation, it is possible, through sharp scalpel dissection to free quickly the non-vasculated parts of lesser omentum, of gastrocolic ligament, as well as the firm adhesions, which usually lie in the hepatoduodenal ligament or anterior duodenal wall. Naturally, the method of procedure will vary according to altered findings. When perforation has not yet occurred, the stomach is readily pulled down, and the lesser omentum incised in the pars flaccida. The left gastric artery is doubly ligated at the level of the stomach corresponding to this incision in the lesser omentum through which the right gastric artery can also be reached to be ligated. Then the peritoneal covering of the lower border of the duodenum is incised. From this starting place, the inferior edge of the pars superior and horizontalis of the duodenum are dissected free by keeping close to the duodenal edge. The small Haberer sound is used to isolate segments which are ligated separately. The pancreaticoduodenal artery on the head of the pancreas is still not ligated and is caught near the stomach antrum where it arises from the right gastro-epiploic artery. The left gastro-epiploic artery is ligated after the gastrocolic ligament is severed. To tie the remainder of this ligament usually requires but a few ligatures.

When a duodenal ulcer is present, and the hepatoduodenal ligament is indurated, it is above all essential to employ wide dissection of the superior duodenum. Only through this step can enough normal duodenum be freed from the contracted periduodenal adhesions to suffice for the proper execution of the Billroth I operation. The anterior wall of the duodenum is freed by

sharp dissection of the adhesions. This permits the duodenum to "climb out of" its indurated adhesions so that its superior and inferior circumferences can be freed in the typical manner already described. Finally, the posterior surface is prepared, and here, normal serosa is an absolute prerequisite for the Billroth I resection.

When a stomach ulcer penetrates into the pancreas, the stomach and duodenum are first freed above and below the ulcer, so that only the site of penetration into the pancreas remains adherent. The adherent perforation is then burned out of the indurated pancreas by a platinum cautery, care being exercised to avoid, if possible, opening the ulcer. The resulting pancreatic callus is then covered by suturing it over very carefully with the pancreatic capsule. Injuries to the head of the pancreas should be very carefully avoided. In cases of this type the ulcer may be opened earlier. This may be done without danger provided the adjoining tissues are walled off.

A similar technique may be used in penetrations into the liver, colon, or the anterior abdominal wall, i.e., cauterization of the base of the ulcer, and exact suturing over of the serosa at the site of perforation.

4. *Resection and anastomosis.* The instrument used is a double clamp which has been developed in von Haberer's clinic (14). It consists of a stomach and a duodenal clamp which are held in the desired relationship by a third clamp. The suture material is fine silk for the seromuscular layers, and fine catgut for the mucosa. The posterior serosa is sutured by very small, semicircular needles—the so-called Billroth needles which are slightly larger than the needles used for blood vessels; in addition, Kader needle holders of two different sizes, and copper, flexible retractors of varied size are used.

The duodenal clamp is fastened just distal to the ulcer on the freed, healthy duodenum. If there is the slightest doubt that an ulcer may still be present further down on the posterior duodenal wall, the clamp is not locked until the duodenum is opened and its condition definitely established. However, as will be later demonstrated, the duodenal clamp is not used in many cases, and only through the omission of the clamp is it possible to approximate and suture after radical resection.

The duodenal end of the stomach is clamped with a soft Doyen clamp to avoid any spilling of its contents. The peritoneal cavity is then carefully walled off, and the duodenum is severed with a cautery about ¾ to 1 centimeter from the

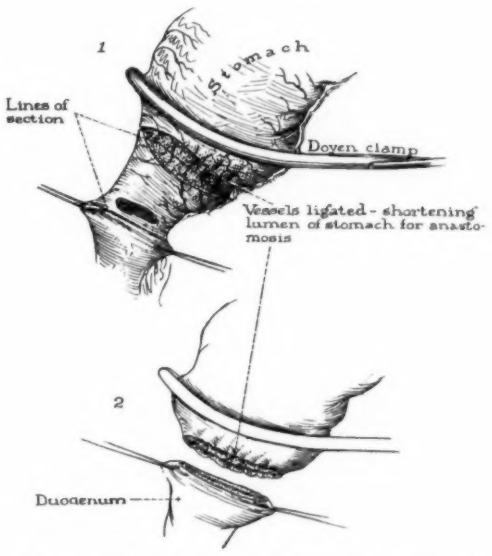

Fig. 5. *1.* Removal of the duodenum. The stomach is closed above the pylorus by a Doyen clamp. Two stay sutures in the duodenum are held by forceps and the freed duodenum is elevated. The anterior wall of the duodenum has already been opened by the cautery. Inspection of the posterior duodenal wall with the ulcer already exposed. *2.* Billroth I showing the suture of the posterior wall and the catgut hæmostatic sutures.

duodenal clamp; the pyloric stump is then covered with a laparotomy sponge; after elevation of the stomach, the stomach clamp is fastened in the regions of the pars media, sliding the clamp from the greater curvature toward the lesser; the two clamps are next united by the third, with the stomach extending out over the left border of the abdominal incision—toward the surgeon's right—so that the posterior surfaces of the stomach and duodenum may be widely approximated.

As a general rule, it is possible to stretch the duodenum wide enough, through stay sutures in its inferior and superior edges, to fit the transverse cut of the opened stomach. The closely approximated posterior, seromuscular, interrupted sutures are next inserted, the fine Billroth I needles and the small Kader needle holder being used. The seromuscular layer of the posterior wall of the stomach is cut about 1 centimeter away from the row of Lembert sutures down to the submucosal blood vessels which are ligated by interrupted catgut suture-ligatures. This procedure decreases postoperative hæmorrhage. The

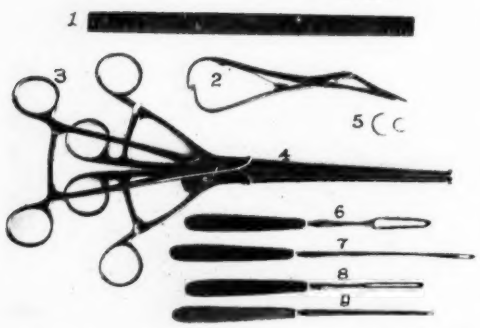

Fig. 6. Special instruments used by Hofrat Haberer for gastric resection. The double clamps, perforated Kocher sounds with aneurism needles to match, needles usually used for suturing the serosa, ruler (25 centimeters) to give approximate size of the instruments photographed.

catgut hæmostatic sutures of von Haberer are very similar to the hæmostatic sutures used by Heidenhain in trepanation. They narrow the lumen of the stomach so that it becomes possible to do an end-to-end anastomosis with the duodenum even in those cases which in the beginning presented a marked disproportion. The sutures are left long.

The stomach is then moved to the patient's right over the taut hæmostatic sutures which are covered by a lap sponge and a flat 3-centimeter retractor to prevent their becoming entangled in another Doyen clamp later used. The seromuscular layer of the anterior wall of the stomach is now incised as was the posterior wall. This incision is about 3 to 4 centimeters from the von Haberer stomach clamp. It is important here to be far enough away from this stomach clamp so that their remains sufficient anterior wall of the stomach to permit the insertion of the final layer of anterior wall, Lembert sutures, without tension and without the necessity or removing the stomach clamp. The submucosal blood vessels are ligated by interrupted catgut sutures in the same manner as were those of the posterior wall.

The stomach segment to be resected is next closed by another Doyen clamp on its oral border and severed by electric cautery between the two clamps (von Haberer stomach and Doyen clamps) about 4 millimeters aboral to the hæmostatic sutures. This is done by first burning a little slit in the mucosa, through which an anatomical forceps is inserted into the stomach lumen and then the mucosa of the anterior wall can be easily burned through between the spread blades of the forceps without injuring the adjacent tissues. The stomach is again turned over to the left and a flat retractor is inserted into the stomach lumen against the still remaining mucosa of the posterior wall which is burned through so that the resected segment is free. The catgut hæmostatic sutures are now cut.

First the posterior and then the anterior walls are sutured by a continuous catgut suture which includes all of the layers of the stomach and duodenum, the beginning and end of this suture are tied together.

The anterior seromuscular suture line is completed by interrupted silk sutures which seek to over-invaginate the duodenum with the seromuscular layer of the stomach. Finally, the duodenum fits into the stomach as the stalk of a mushroom fits into its pileus. This end-to-end Billroth I anastomosis, with all of the stomach lumen entering into the anastomosis, is generally over two fingerbreadths long but we have never seen stenosis.

It is only rarely possible to complete the anastomosis with both clamps *in situ*. As a general rule it is necessary to remove the duodenal clamp in order to be able to finish the anterior seromuscular suture. In a certain percentage of cases, the duodenal clamp must be removed after the duodenum has been stretched to match the stomach lumen by the superior and inferior stay sutures, so that the posterior serosa sutures can be inserted. In many cases, the duodenal clamp must be abandoned. Here before the duodenum is either opened or cut the two stay sutures are inserted and held tautly elevated to prevent spilling of the duodenal contents. Moreover, any pressure upon the duodenum must be avoided.

5. *Closure of the abdomen.* The abdominal wall is closed in layers: the peritoneum by continuous silk, the fascia with interrupted silk, and the skin with clamps.

6. *End-to-side modification of the Billroth technique (Haberer-Moynihan).* In those cases in which it is impossible to obtain a good serosa on the posterior duodenal surface, the Billroth I operation is contra-indicated. Instead, the duodenal stump is buried by being covered with two rows of sutures, the first being continuous catgut, followed by silk Lembert sutures which include the pancreatic capsule in covering the duodenal stump. There now still remains the possibility of obtaining the advantages of the Billroth I anastomosis by utilizing the end-to-side von Haberer modification. The duodenum is mobilized markedly by means of the cutting of the peritoneum laterally and to the right of the pars descendens of the duodenum (vena cava is now

exposed). Then the transverse cut edge of the stomach is anastomosed to the pars descendens of the duodenum with two rows of sutures either terminolateral or end-to-side.

End-to-side anastomosis is contra-indicated in many cases because of dense adhesions or unfavorable position of the head of the pancreas. The antecolic Billroth II resection together with a Braun's entero-anastomosis then becomes the operation of choice. Because of limited space, it is inadvisable to discuss further the modifications of the Billroth I technique which may be needed in ulcers of the cardia, in perforated ulcers, in hæmorrhage or other complications.

POSTOPERATIVE TREATMENT

After operation, nothing is given by mouth for the first 12 to 36 hours, or as long as the patient is nauseated, weak tea in very small amounts being the first food. Thirst is combated by physiological salt solution and glucose *per rectum* by the drip method. Black coffee is included in these enemas for stimulation.

Patients in shock or very emaciated or starved patients are given intravenously 50 to 150 cubic centimeters of 50 per cent glucose together with 40 to 80 units of insulin (8).

Hæmorrhage from the stomach after operation has practically disappeared since we have been using the catgut hæmostatic sutures. The patient is kept on a liquid diet for 7 days, and remains in bed 14 days. About 17 or 19 days after operation, the patient is fluoroscoped. In cases of emesis or moderate gastric atony, the stomach is washed out. Threatened lung complications are treated by forced deep respiration, carbon dioxide inhalations; camphor and lobelin; morphine is given for pain. As a prophylaxis against pneumonia, Bier's ætherpsicain, afenil, and heart stimulants such as digipuratum, or digitalis are used. Cases of beginning pneumonia receive carbon-dioxide inhalations, 10 cubic centimeters of camphor in oil, 80 to 800 cubic centimeters of 4 per cent colloidal iron sugar solution intravenously, as well as the customary therapy. Before discharge from the hospital, all patients are given definite dietary directions and are instructed to return for control examination once a year.

EARLY POSTOPERATIVE COMPLICATIONS

1. Peritonitis, secondary to separation and leakage at the suture line, is a rare but usually fatal complication. It is found occasionally in very cachectic patients or may result from digestion of the sutures in those cases in which the pancreas —especially the head— has been traumatized by faulty technique. Separation of the suture line in Billroth I, secondary to excessive tension, can be avoided if the duodenum is properly prepared and if the operative indications are carefully applied.

2. Subphrenic abscesses and empyema are much less common after a Billroth I than after a Billroth II operation. These complications are curable if diagnosed early enough and drained.

3. The most common complication is pneumonia which occurs just as frequently after local as after general anæsthesia. Its etiological basis may be either an existing bronchitis, bronchiectasis, or tiny lung emboli. Prophylaxis consists of minimizing tissue damage and limiting evisceration with resulting cooling of the intestines. Gangrene of the lung which may follow accidental aspiration during general anæsthesia is treated by salvarsan.

4. Prior to the use of the hæmostatic sutures of the submucosal blood vessels, hæmorrhage was relatively frequent; but it has now practically disappeared. Treatment consists of abstinence from food, ice-bag to the stomach, irrigation of the stomach with from 10 to 20 liters of ½ per mille lapis solution, calcium-gelatin, and serum or blood transfusion.

5. Brown atrophy of the heart from chronic malnutrition may lead to failure of the circulation. Its existence can only be suspected but not definitely diagnosed in exsanguinated patients or those who have suffered from chronic ulcers for many years.

6. Fatal emboli did not occur in this series of cases.

7. A mild postoperative parotitis will occasionally occur after gastric resection for ulcer.

LATE COMPLICATIONS

The following late complications may be decreased by the use of the Billroth I type of resection:

1. In cases of resection in which there are multiple ulcers (12) of the duodenum, it is easy to overlook one which leads to the so-called "apparent" recurrences. Careful anatomical exploration, which is possible in the Billroth I resection, will decrease this oversight and eliminate the "apparent" recurrences.

2. The "scar" recurrence is found after the Billroth I resection when the duodenum used in the anastomosis is either pathologically scarred or the ulcer not completely healed. Proper evaluation of the anatomical findings at operation will limit the Billroth I resection to the indicated cases and eliminate this error.

3. A small percentage of patients complain of so-called "small-stomach," but as a general rule, the early postoperative, rapid, or precipitate emptying of the Billroth I stomach stump is gradually replaced by normal stomach emptying.

There was a 4 to 5 per cent postoperative mortality and 96 per cent cures in a series of over 1200 Billroth I resections which included all difficult cases and patients of all ages (11).

BIBLIOGRAPHY

1. HABERER. Wien. klin, Wchnschr., 1920, xxviii.
2. Idem. Zentralbl. f. Chir., 1921, xlviii, 847.
3. Idem. Indicationstellung fuer die chirurg. Behandlung bei boesartigen und gutartigen Erkrankungen des Magens und Duodenums auf Grund von Erfahrungen an 1432 eigenen Faellen. Samml. zwangl. Abhandl. a. d. Geb. d. Verdauungs-u. Stoffwechs.-Krankh., viii, 2.
4. Idem. Anwendungsbreite u. Vorteil der Magenresection nach Billroth I. Arch. f. klin. Chir., cxiv.
5. Idem. Arch. f. klin. Chir., 1922, cxix, 712–765.
6. Idem Arch. f. klin. Chir., 1922, cxxii, 534–552.
7. Idem. Mitt. a. d. Grenzgeb. d. Med. u. Chir., xxxi.
8. Idem. Deutsche Ztschr. f. Chir., 1926, cxcv, 80.
9. Idem. Arch. f. klin. Chir., 1927, cxcvi, 651.
10. Idem. Der Pylorus. Antrittsvorlesung. Graz: Leuschner & Lubensky, 1924.
11. Idem. II Tagung alpenlandischer Chirugen, Linz, Sept. 1926; Deutsche Ztschr. f. Chir., 1927, cc, 212.
12. KRAFT. Wien. klin. Wchnschr., 1927.
13. LOURIA. A series of 300 Billroth I and Billroth II resections for ulcer done in the Surgical Clinic of Graz. To be published in Surg., Gynec. & Obst.
14. MAIER. Deutsche Ztschr. f. Chir., cxcv.
15. ORATOR, V. Arch. f. path. Anat., cclvi.
16. ORATOR, V and METZLER, F. Klinische und experimentelle Beitraege zur Ulcusfrage. Deutsche Ztschr. f. Chir., 1927, ccii, 167.
17. PAUL. Deutsche Ztschr. f. Chir., 1922, clxxii, 94–116.
18. STOCKER. Deutsche Ztschr. f. Chir., ccviii.
19. TSCHEBULL. Deutsche Ztschr. f. Chir., cxcv.

FROM THE ORTHOPEDIC SERVICE, MASSACHUSETTS GENERAL HOSPITAL

ARTHROTOMY OF THE HIP

By NATHANIEL ALLISON, M.D., F.A.C.S., Boston

THE hip joint is deeply placed and is surrounded by numerous muscles. The psoas and iliacus are in front of the articulation. Behind it are the quadratus femoris, the obturator internis, the two gemelli, and the pyriformis. To the outer side lie the gluteus medius and minimus and rectus, and to the inner side are the pectineus and obturator externus.

The hip joint has an exceedingly strong capsule made up of white fibrous tissue which is thickest in front. Its re-enforcing ligaments are the strongest in the body and include the iliofemoral, the ischiofemoral, and the pubofemoral ligaments; the pubofemoral and the iliofemoral forming what is known as the Y-ligament of Bigelow. The thinnest part of the capsule lies between the iliofemoral and pubofemoral ligaments, and here the joint cavity often communicates with a small bursa which lies below the psoas muscle. The hip-joint capsule is also weak where it is covered by the obturator muscles.

The upper border of the great trochanter is on a level with the center of the hip joint. Nélaton's line extends from the anterior superior spine of the ilium to the most prominent part of the tuberosity of the ischium, running across the center of the acetabulum and passing over the top of the great trochanter.

The head of the femur lies just below and to the outer side of the central point of Poupart's ligament.

There are descriptions in surgical literature of many different methods of carrying out the operation of arthrotomy of the hip. The operation has been recognized as an important one since a remote period of surgical history. The names of such surgeons as Lisfranc, Sedillot, Percy, Roux, Langenbeck, Lucke, Barber, Kocher, and many others are associated with methods of opening the hip joint. Indeed, Farabeuf (1841–1910) assembled in his treatise on operative surgery[1] 18 different methods of performing the operation.

In times past the operation of arthrotomy of the hip was done in desperate haste for desperate conditions. Surgical skill reached its maximum of deftness in doing the operation, and considerable pride was taken in stop-watch records. The necessity for haste was very urgent for excision of the hip was attended by terrible mortality. Treves gives statistics collected by Otis in 1891, showing a death rate of 90.9 per cent following gunshot wounds. The same statistics show that the mortality without operation was 98.8 per cent. When amputation was promptly done the mortality was 83.3 per cent. Bryant, in 1887, stated that when the operation of hip resection was done for disease, the mortality ranged from 15 to 45 per cent. In gunshot wounds, death occurred in 92.5 per cent from primary operation; in 91 per cent from infection, and in 90.5 per cent following secondary operation. Present day surgical methods have made the operation less lethal in character, and have vouchsafed to the surgeon a greater sense of security than was felt by the past generation. Nevertheless, the operation of arthrotomy of the hip remains a major surgical procedure, one not to be undertaken lightly, and one requiring surgical experience and judgment as well as skill and deftness in the handling of tissues.

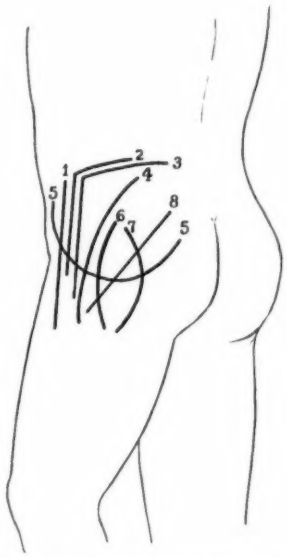

Fig. 1. Some of the approaches to the hip joint. *1*, anterior; *2*, Sprengel, Smith-Petersen; *3* and *4*, Kocher; *5*, Ollier; *6*, Sayre; *7*, Bryant; *8*, Ober.

[1]Published by Masson et Cie, Paris.

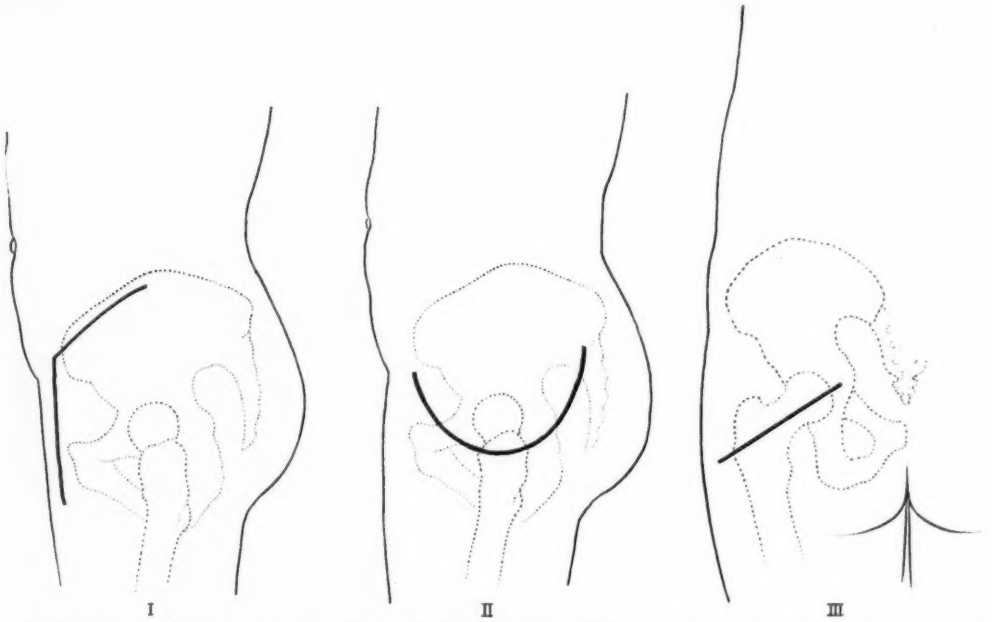

Fig. 2. Drawings showing the anterior, *I*, lateral, *II*, and posterior, *III*, approaches. These three methods are best adapted to the performance of arthrotomy of the hip.

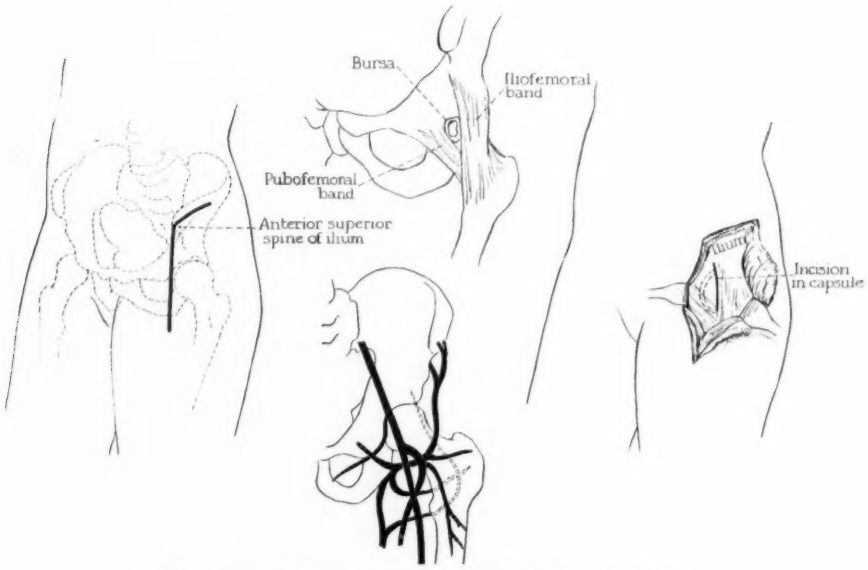

Fig. 3. The anterior approach, called the Smith-Petersen approach.

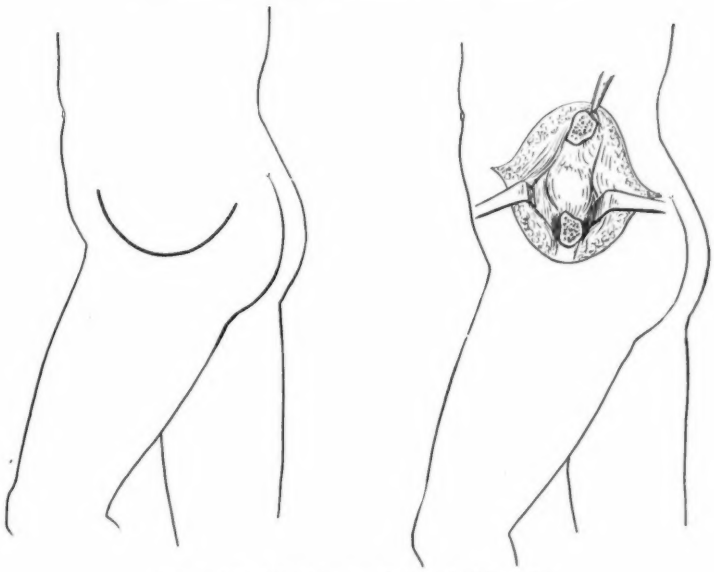

Fig. 4. The lateral approach described by Ollier.

Operations on the hip joint have various objects: drainage of an infection; repair of a fracture; or plastic reconstructions upon the head and neck of the femur or the acetabulum. In some cases it may be necessary to excise the joint, or create an ankylosis, or attempt to re-establish motion in an ankylosed hip. At times the hip may be flail or wobbly because of paralysis, and a stabilization of the joint may be needed. Other objectives of surgical treatment also may arise. In consequence, several useful methods of approach to the hip have been devised, and it is of great importance in each case to select the method of approach which will best allow the accomplishment of the end required.

Arthrotomy of the hip should be done only with the full realization on the surgeon's part of the importance of all the details of operative technique and after-care. The surgeon must be fully cognizant of the dangers in general and in particular to each individual patient. He must know exactly why, when, and how the operation should be performed.

The dangers, in general, encountered in arthrotomy of the hip are those common to any serious surgical procedure performed upon patients who, as a rule, are not in good physical condition. Consequently, the operation must be done with reasonable speed and with due regard to the tissues. Severe traumatism of soft parts and of bone tissue must be avoided. Surgical shock from trauma and loss of blood are the chief dangers. It goes without saying that operative infection is a most disastrous result, insuring always a long period of serious illness with high mortality. Nowhere in surgery are a careful technique and a rigid asepsis more necessary.

As a rule, arthrotomy of the hip should be done only for urgent reasons, such as, pain in the hip or inability to walk; or in order to stabilize a tuberculous hip or to drain an acute infection of the joint.

If a condition warrants operative interference, the operation should be done as soon as possible after the conditions have been properly weighed and studied. Satisfactory roentgenograms should be obtained before operation is decided upon.

Among the lesions which may require hip arthrotomy are the following: acute infections of the hip joint; tuberculosis of the hip in adults—so-called hip fusion; fracture of the femoral neck—reconstruction or bone plastic; unreduced traumatic dislocations of the hip; arthritis of the hip, with painful motion or loose bodies; disarticulation or amputation for sepsis; ankylosis of the hip, so-called arthroplasty; unreduced displacement of the upper femoral epiphysis; obscure arthritis demanding tissue examination; congenital dislocation in young adults or adults; and stabilization of the hip in paralysis, notably poliomyelitis.

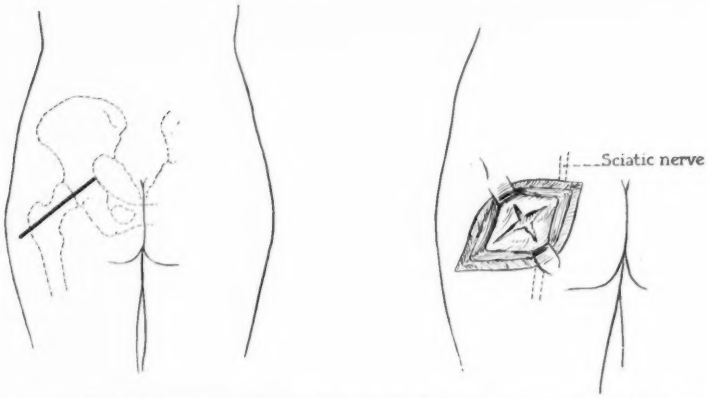

Fig. 5. Posterior approach, described by F. R. Ober. Most useful for drainage and for biopsy on the hip.

Other conditions and variations of lesions just mentioned may also make it necessary for the surgeon to proceed to arthrotomy of the hip.

METHODS

There are three useful methods of approach to the hip, i.e., anterior, lateral, and posterior, and it is important to select the method which will best favor that which is to be accomplished after the hip is opened.

We have found on the Orthopedic Service at the Massachusetts General Hospital that the anterior approach is best suited to those cases of hip lesion in which a disarticulation of the femoral head is necessary, and in which it is probable that some type of osteoplastic operation is indicated upon the femoral head or acetabulum, or the margins of the latter. Therefore, the anterior approach is to be used in the following lesions: tuberculosis of the hip in adults, so-called hip fusion; unreduced traumatic dislocations of the hip; arthritis of the hip, with painful motion or loose bodies; ankylosis of the hip, so-called arthroplasty; congenital dislocation in young adults or adults; and stabilization of the hip in paralysis, notably poliomyelitis.

We have found also that the lateral approach is best in fracture of the femoral neck—reconstruction or bone plastic; and in disarticulation or amputation for sepsis.

We have made use of the posterior approach in the following lesions: acute infections of the hip joint; unreduced displacement of the upper femoral epiphysis; and obscure arthritis demanding tissue examination.

Each method of approach has certain advantages in some lesions and disadvantages in others. For instance, the removal of the trochanter major, which is necessary in the lateral approach, is not the best approach for drainage of the joint in acute infections; for obvious reasons, the posterior approach is best in this instance. Likewise, the anterior approach is not advisable for reconstruction operation in ununited neck fracture because in this instance a bone plastic must be done on the greater trochanter. Obviously, the lateral approach is indicated in this lesion. Furthermore, neither the lateral nor the posterior approach will give sufficient exposure for bone plastic measures on the neck and head or the acetabular margin—here the anterior approach is best. Of the three methods of approach, it is fair to say that the anterior is the most difficult and damaging; next, the lateral; and least damaging, the posterior. In consequence, it is beyond question better to use the posterior approach in all operations done for the purpose of tissue removal for diagnosis, and in all attempts to establish drainage in infections of the hip.

PREPARATION

The patient's general condition should be the best possible under the circumstances before operation is done. If possible, several days of rest, with good sleep, should be secured. The skin should be shaved and cleansed with soap, water, ether, and alcohol before the operation. The ordinary pre-anæsthetic precautions should be observed. The skin over the entire hip region should be painted with iodine, and the operative field carefully draped with sterile coverings. It is always necessary to manipulate the leg and thigh during the operation; consequently, it is essential to cover the patient so that the hip on the side to be operated upon may be moved without danger

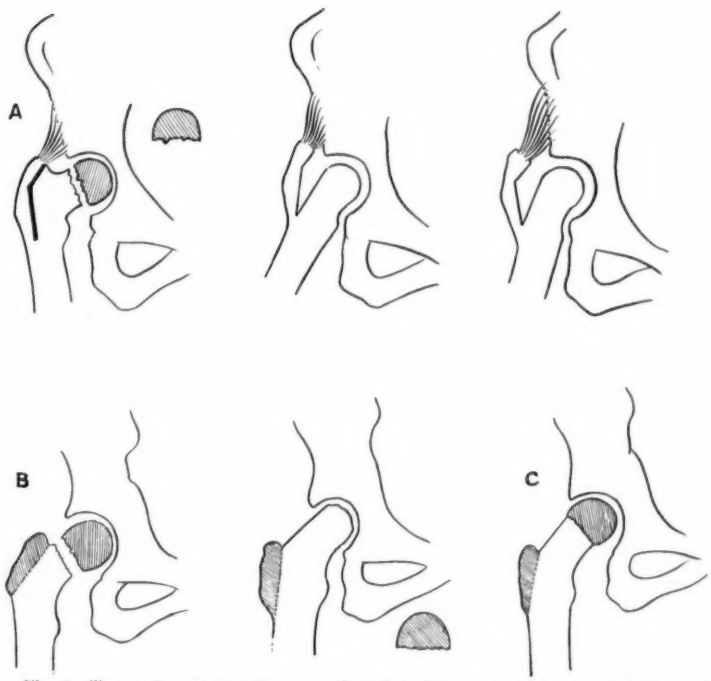

Fig. 6. Types of reconstruction operations done for ununited fracture of the femoral neck. *A*, Albee operation and *B*, the Whitman operation. In both of these operations the head of the femur is removed. *C*, Brackett's operation—the fractured head is replaced on its stump of the neck. Whitman's operation and Brackett's operation both require transplantation of the greater trochanter.

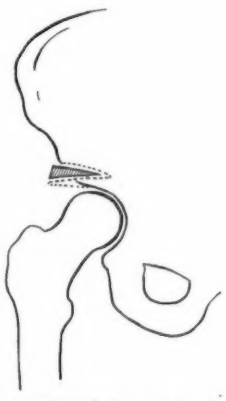

Fig. 7. Reconstruction of the margin of the acetabulum. Useful in dislocation of the hip, either congenital or due to paralysis. A shelf is turned down from the margin of the acetabulum and wedged out with a bone transplant (Dickson's operation).

to the technique of operation. This is done by encasing the foot, leg, and thigh in a sterile cover, outside the rest of the sterile coverings so that the operator may grasp the leg and thigh and manipulate the hip without breaking asepsis.

We commonly use three methods of approach in arthrotomy of the hip. Taking them in order, the steps of the anterior, lateral, and posterior methods are as follows.

ANTERIOR APPROACH

There are several methods of anterior approach. The one used by us is perhaps better described as the superior-anterior approach and is called by us the Smith-Petersen method. A similar method was used by Sprengel in Germany about 100 years ago, and later by Anderson in England. Kocher describes this approach for removal of the ilium. We call the method the Smith-Petersen approach because of his re-discovery in 1917 of the value of this method of opening the hip joint.[1]

[1] Smith-Petersen, M. N. Am. J. Orthop. Surg., 1917, xv, 529.

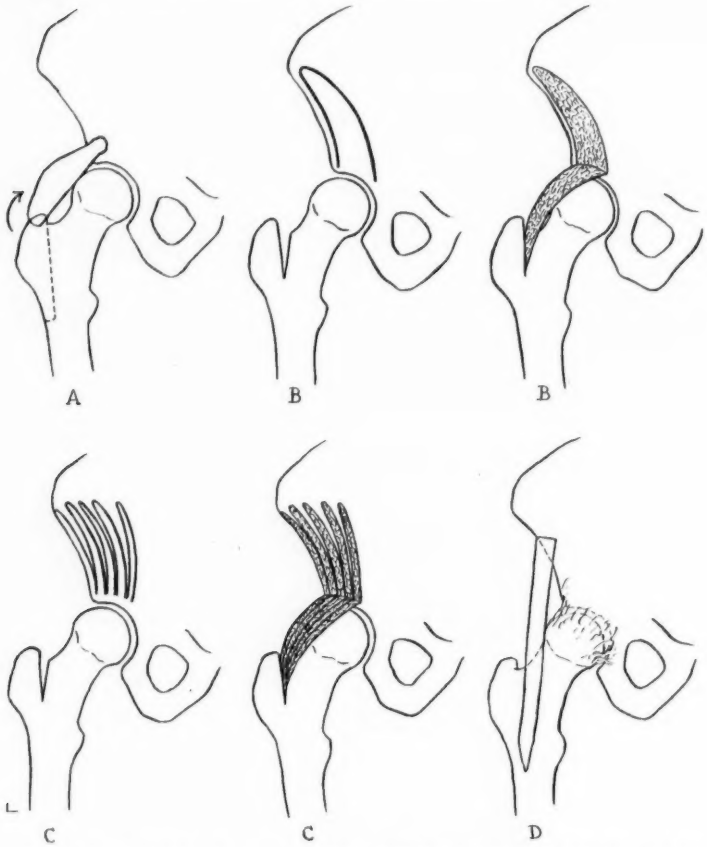

Fig. 8. Arthrodesis of the hip. *A*, Hibbs' operation for fusion of the hip. A bone transplant is made and the trochanter major is turned upward over the neck and imbedded in the ilium. *B*, J. C. Wilson's operation for fusion of the hip. A bone flap is turned down from the surface of the ilium over the neck and the femur implanted in a groove produced by the elevation of the greater trochanter. *C*, Ober's operation for fusion of the hip. The "crown roast" method. Numerous small bone fragments are turned down over the neck of the femur from the ilium into a split between the trochanter and the shaft. *D*, Allison's operation for fusion of the hip. A bone transplant taken from the tibia is imbedded in the neck of the femur and in the surface of the ilium across the hip joint. These operations are intended to be extra-articular and are useful in the production of ankylosis of the hip in tuberculosis.

The patient lies on his side, one-third the way over, with a long sand bag against his back.

1. A curved incision is made over the crest of the ilium from the anterior spine to a little beyond the middle of the crest.

2. A vertical incision is made on the anterior thigh from the anterior superior spine of the ilium to about 4 or 5 inches downward from the spine.

3. These two cuts make an angle with each other at the anterior superior spine. The skin and subcutaneous tissue being divided, the wound edges are covered with skin towels clipped securely in place.

4. The upper arm of this angular incision should be completed first. Beginning at the anterior superior spine, the incision is carried directly downward to the bone, the origin of the gluteus medius being cut and the periosteum incised. With a sharp periosteal elevator the periosteum is now elevated from the ilium, the muscles being carried

with it. The depth of the wound is packed with gauze strips.

5. The vertical arm of this angulated incision is completed by the intermuscular planes being entered between the sartorius anteriorly and the tensor fasciæ femoris posteriorly. The fascia is the only structure demanding division, and by retraction the anterior surface of the hip joint capsule is clearly seen. The capsule should be divided in such a way as to preserve the iliofemoral Y-ligament of Bigelow. After the freeing of the capsule from the cotyloid ligament at the acetabular margin, a vertical cut is made along the border of the iliofemoral band of the Y-ligament. This exposes the anterior external aspect of the head of the femur. By flexion of the thigh and external rotation, the head of the femur is delivered. The exposure thus accomplished gives access to the acetabulum, and the entire head and neck of the femur.

6. The flap is turned back after suture of the capsule, the gluteus medius is stitched to its periosteal attachment and the anterior line of suture is closed in layers.

LATERAL APPROACH

The lateral or Ollier's approach, in which the hip from the region of the great trochanter is opened, was recently advocated by J. B. Murphy[1] as a proper approach for arthroplasty of the hip. Lexer also advised this manner of approach to the hip for arthroplasty. Baer has used it as the method of choice in his operations for re-establishment of motion at the hip. To us it seems less suited to arthroplasty than does the anterior approach because of the necessity for fracture at the region of the greater trochanter.

The patient lies on his side with the thigh flexed to 45 degrees.

1. A curved incision through skin and subcutaneous fat is made starting at the anterior superior spine and running to the posterior superior spine. The curve is flat, U-shaped, with its lowest point about 1 inch below the tip of the greater trochanter. The flap is turned upward exposing the tip of the trochanter. The aponeurosis of the gluteus maximus is divided vertically and retracted backward.

2. The trochanter major is now cut through about 1 inch below its tip. The direction of this osteotomy is oblique, so that the upper end of the cut is at the upper surface of the femoral neck. This detached fragment is pulled upward, and carries with it the muscles which have insertion at the greater trochanter, i.e., the gluteus medius, gluteus minimus, pyriformis, and gemelli.

[1] Murphy, J. B. Arthroplasty, 1909.

Fig. 8a. Roentgenogram showing bone transplant taken from the tibia and planted in the ilium and femur across the hip joint, as described by the author.

3. The anterior margin of the gluteus medius is dissected from the posterior margin of the tensor fasciæ femoris. This exposes the upper surface of the joint capsule and the acetabular margin.

4. The capsule is divided vertically, and the head of the femur dislocated by adduction and internal rotation of the thigh.

5. The fragment of the trochanter is sutured in place either by catgut stitches or a bone pin. The muscles are sutured together by interrupted sutures. The skin is sutured with silk, either an interrupted or continuous stitch being used.

The lateral approach is admirably suited to removal of the head of the femur in old ununited fractures, especially when some type of reconstruction is to be done, as in the Whitman or Brackett operation. The reshaping of the neck and trochanter region is more easily accomplished. It is less damaging to the hip region than is the anterior approach; it requires less time for exposure; and, consequently, is advisable as an approach in patients of advanced years, or in those of poor physical condition.

POSTERIOR APPROACH

This method has been described by Ober[2] and is called by us the Ober method. This approach is not desirable in conditions in which exposure of the head of the femur is required. Its use is for drainage of the hip joint or removal of tissue for examination and diagnosis. Ghormley has recently used it for replacement of slipping of the upper femoral epiphysis with good result. Langenbeck

[2] Ober, F. A. Posterior Arthrotomy of the Hip. J. Am. M. Ass., 1924, lxxxiii, 1500-1502.

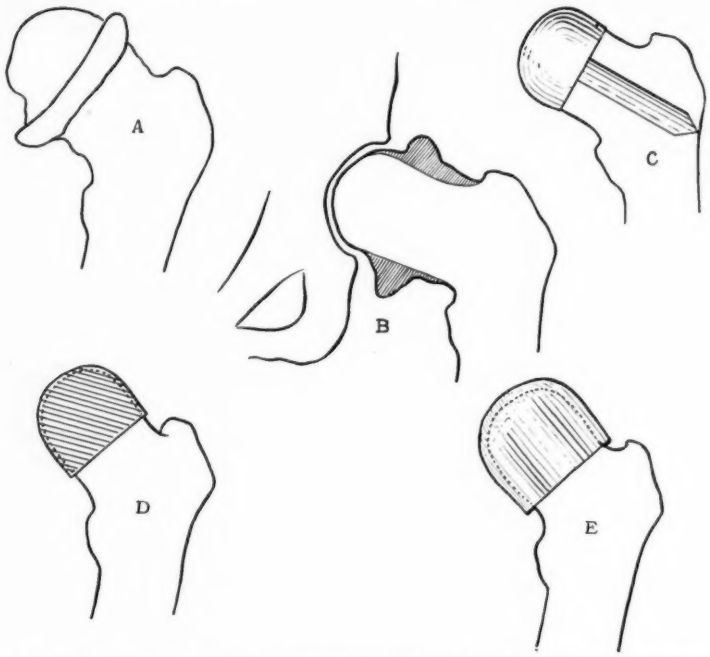

Fig. 9. Bone plastic operations and arthroplasties. Chronic arthritis with marked deformity of the femoral neck and head shown in *A*. The head may be trimmed down, as shown in *B*. Hey-Groves has suggested the use of an ivory head as shown in *C*. Arthroplasty is ordinarily accomplished by the use of fascia for interposition after the head is remodeled, as shown in *D*. Methods of Putti, Bear, who uses chromicized pig's bladder, and Willis Campbell. A non-absorbable interposition substance, celluloid, has been used by Allison and Smith-Petersen, as shown in *E*.

and Kocher have described somewhat similar approaches.

1. The patient lies face down on the table. The buttock and upper thigh are prepared for operation.

2. Incision is made in a straight line running from the posterior lateral aspect of the femur obliquely upward and backward toward the sacrococcygeal articulation, directly over the neck of the femur and in the line of the fibers of the gluteus maximus.

3. The fibers of the gluteus maximus are separated.

4. The underlying fat is pushed aside by blunt dissection, care being used to *avoid the great sciatic nerve* which is in the region of the medial extremity of the incision. The tendon of the obturator internus, the quadratus femoris, and the gemelli and pyriformis are now exposed and separated by blunt dissection, and retracted, to expose the posterior surface of the joint capsule.

5. The joint capsule is divided the whole length of the incision, and drainage or removal of tissue is accomplished.

6. In order to maintain drainage, the capsule may be sutured to the gluteal fascia, or cigarette drains may be stitched to the capsular margins.

7. Closure is simple, requiring approximation of the edges with catgut sutures. The skin is sutured with silk.

POSTOPERATIVE CARE

After arthrotomy of the hip, the surgeon should always have in mind the danger of surgical shock. The patient, as a rule, should be handled as though surgical shock were present; a shock enema, a warm bed, morphine in sufficient quantities, and forced fluids are best employed in each instance.

Each different condition requires a particular type of after-care. In general, when motion at the hip is the object of the operation, i.e., arthroplasty or drainage of infection, the hip should be put up

in overhead suspension so that the patient may move it as soon and as much as possible, without pain.

In all procedures in which bony union is sought, especially in fusion for tuberculosis, or in fracture of the neck of the femur, the hip should be fixed in a plaster-of-Paris spica. It is often advisable to include the thigh of the opposite side in the plaster dressing in order to fix the hip.

Whenever arthroplasty of the hip is done, and, indeed, for whatever purpose it is done, it is necessary for the patient to be recumbent in bed for a considerable period of time. Consequently, good nursing-care is essential, both for the period of bed care and for the long period of re-adjustment when the patient is up with crutches seeking to re-establish function.

The prognosis depends entirely upon the condition for which the operation is performed. Each lesion carries with it certain unfavorable potentialities which result as a rule in more or less permanent impairment of the hip-joint function.

GASTRO-ENTEROSTOMY WITH A TRANSVERSE JEJUNAL INCISION

Preliminary Clinical Report

By THEODORE S. MOISE, M.D., New Haven, Connecticut

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ALTHOUGH the success of any type of gastro-intestinal anastomosis is largely dependent on its mechanical efficiency, there are certain faults inherent in the motor mechanism of gastrojejunostomies performed according to the orthodox methods. These shortcomings are in large part due to the longitudinal jejunal incision, which severs the circular muscle fibers and interferes with peristalsis throughout the length of the stoma. This insufficiency of the motor mechanism after the usual procedures suggested the probable superiority of a different type of anastomosis, whereby a minimal amount of injury would be inflicted upon the circular muscle fibers of the intestine. This can be effected quite easily by the use of a transverse jejunal incision.

The mechanics of the orthodox side-to-side gastrojejunostomy have been the subject of an extensive experimental study by Cannon and Blake (1). These investigators repeatedly noted that food was forced through the patent pylorus to re-enter the stomach via the proximal loop. This circulation of food was seen when the stomach was stretched by large amounts of food or water. They explained this phenomenon by the "valve like" action of the anastomosis. When the wall of the stomach is stretched, so that the edges of the opening into the jejunum are separated the intestinal wall becomes flattened over the stoma and the openings into the intestine become merely narrow slits (Fig. 1). The opening on the proximal side of the stoma permits food which circulates via the pylorus and duodenum to return into the stomach, but both slits offer a "valve-like" hindrance to the egress of food from the stomach via the stoma. The more the gastric

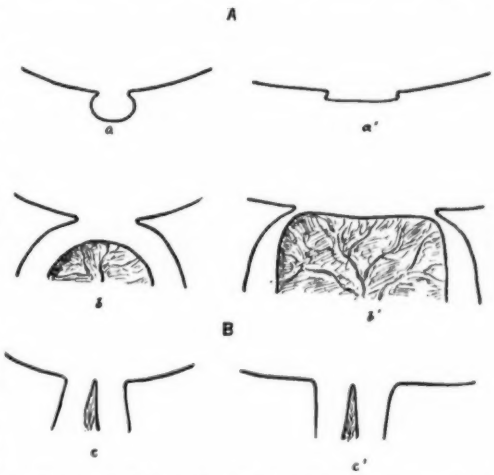

Fig. 1. A diagram showing the effect of extreme gastric dilatation on the stoma, A, in the usual side to side gastro-enterostomy (longitudinal jejunal incision); B, in the new type of procedure (transverse jejunal incision). The normal stoma is represented in the usual procedure in *a*, and *b*, in cross section and longitudinal section respectively, and *c*, represents a longitudinal section through the stoma after a gastro-enterostomy with a transverse jejunal incision. The dilated stomach is represented in *a*, *b* and *c*; the mechanism of valve formation is illustrated in *a* and *b*, while in *c* the dilatation produces an enlargement of the stoma.

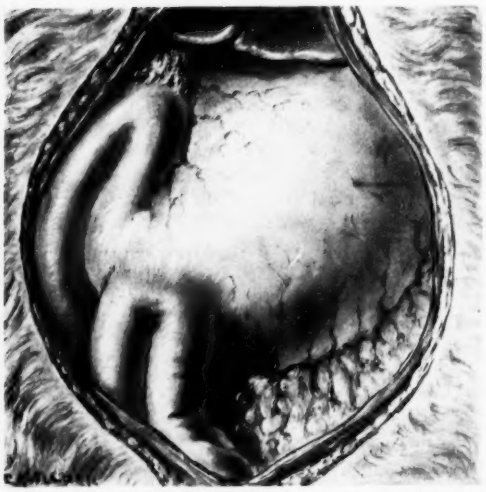

Fig. 2. The drawing illustrates an experimental gastroenterostomy with transverse jejunal incision as it appeared *in situ* after complete healing. The jejunal loops hang directly downward tending to maintain the patency of the lumen. The transverse jejunal incision produces a minimal injury to the circular fibers and accordingly there is no flattening of the intestine at the site of the stoma.

Fig. 3. The drawing illustrates an experimental gastroenterostomy performed according to the usual technique with a longitudinal jejunal incision as it appeared *in situ* after complete healing. The stoma functioned normally and there was no stasis but a comparison with Figure 2 shows a flattening of the jejunal wall in the area of division of the circular muscle fibers. One can readily see how the natural tendency for the intestine to gravitate downward is an advantage with the transverse jejunal incision (Figure 1, *c*, *c'* and Figure 2) but may produce angulation and possibly an obstruction with the usual longitudinal jejunal incision.

wall is stretched, the more effective the valves become. This phenomenon was also demonstrated in the excised stomach by distending it with water. Moreover, the division of the circular muscle fibers at the stoma in the usual side-to-side gastrojejunostomy makes it impossible for peristalsis to be effective at the angulation in the jejunum at the distal end of the anastomosis and hence the force that normally pushes the food along and straightens the kink is lacking.

Various modifications have been suggested to avoid these defects in the side-to-side gastrojejunostomy. Kelling (3) thought that kinking was produced when the stoma was made too large so that when the stomach was stretched and the stoma further enlarged a spur of intestine might project into the gastric cavity. Case (2) suggested that kinking might be entirely prevented by attaching a few centimeters of jejunum beyond the distal end of the stoma to the stomach wall.

Moise and Harvey (6) described a method of gastro-intestinal anastomosis after a partial gastrectomy wherein the jejunum is incised transversely rather than longitudinally and the end of the stomach is anastomosed to the end of the jejunum. The advantages of such a procedure over the usual end-to-side or side-to-side anastomoses are several. The procedure is an end-to-end anastomosis and should have the mechanical and physiological advantages that are generally conceded for this type of operation. In contrast with usual methods, one avoids cutting the circular muscle fibers, and accordingly there is no interference with peristalsis and no opportunity is afforded for the formation of an atonic, dilated pouch opposite the stoma. After this end-to-end gastrojejunostomy, the two jejunal loops naturally gravitate downward, which is the optimum position for the maintenance of a patent stoma, while this same tendency for the loops to drop down after the Pólya anastomosis may tend to kink and partly occlude the lumen.

In a later communication Moise, Haagensen and Vogt (7) reported a comparative study between a series of gastrojejunostomies in dogs, with the orthodox longitudinal jejunal incision and a similar series in which a transverse jejunal incision was utilized. The operative technique, the size and placing of the stoma, were identical in the two series. The functional results in the ten end-to-side anastomoses (transverse jejunal

Fig. 4. The drawing illustrates an instance of a dilated stomach after the usual gastro-enterostomy (longitudinal jejunal incision) with the valve formation described by Cannon and Blake. There is moderate angulation of the jejunal loop at the distal end of the anastomosis. The obstruction and concomitant stasis are due to this valve formation and angulation. This was observed in several instances (3 in 10) with the usual gastro-enterostomy with longitudinal jejunal incision but in no instance with a transverse jejunal incision.

incision) were uniformly good. The roentgenographic studies showed that the stomach usually began to empty immediately after feeding. The emptying was never precipitous. The average emptying time for the series was 5¼ hours, which is approximately the same as that of a normal dog under similar conditions. In animals without pyloric exclusion, the emptying was via both the pylorus and the stoma.

Finally, examined *in situ* the anastomoses looked much as they did upon completion of the operation. The stomach was never dilated. The loops of jejunum hung directly downward in the ideal mechanical position (Fig. 2)[1]. There was no evidence of "valve" formation or kinking. Upon removal the specimens showed patent lumina about the size of a cross section of the normal jejunum.

In contrast, there were three poor results in ten side-to-side anastomoses (longitudinal jejunal incision). In the 7 normally functioning anastomoses, the average emptying time was slightly longer than 5 hours (Fig. 3). In the poorly functioning instances (3 in 10), there was definite evidence of gastric retention determined by roentgenographic study. In two animals the obstruction progressively became more and more marked and was associated with vomiting and emaciation. At approximately a month and a half after operation, fluoroscopic examinations showed that the stomachs were greatly dilated and full of fluid. They did not empty perceptibly within 6 hours, and after 3 days showed marked retention. At autopsy, there was marked gastric distention (Fig. 4). In each case the stoma was much enlarged and the opposite intestinal wall, where the circular muscle fibers had been cut, was markedly stretched and ballooned out in line with the stomach wall, illustrating the "valve" formation described by Cannon and Blake.

The loops of jejunum gravitated downward from either extremity of the dilated stoma with moderate angulation of the gut at the distal end of the anastomosis. In the third animal a similar, though less marked, condition was observed. It seems highly probable that the animals took too much food or water, thus producing distention with the concomitant "valve" formation, and this condition, once established, gradually became more and more marked by the accumulation of normal secretions or by the further ingestion of food and water.

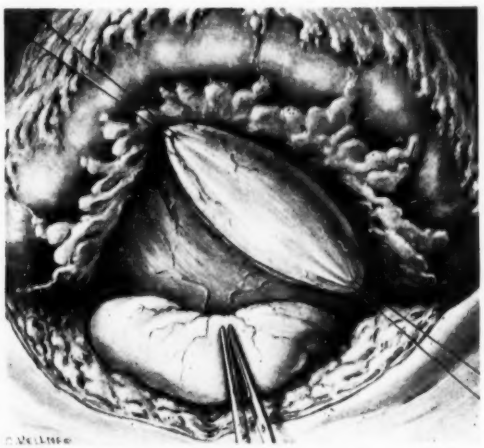

Fig. 5. The opening in the transverse mesocolon has been made. The edges of the opening in the mesocolon have been sutured to the stomach wall. The two guide sutures indicate the line of the proposed gastric incision. The crushing clamps have been applied to the jejunum and an incision has been made across the intestine leaving a margin of one quarter of an inch at the mesenteric border.

[1]For anatomical reasons an anterior gastro-enterostomy is preferable in dogs.

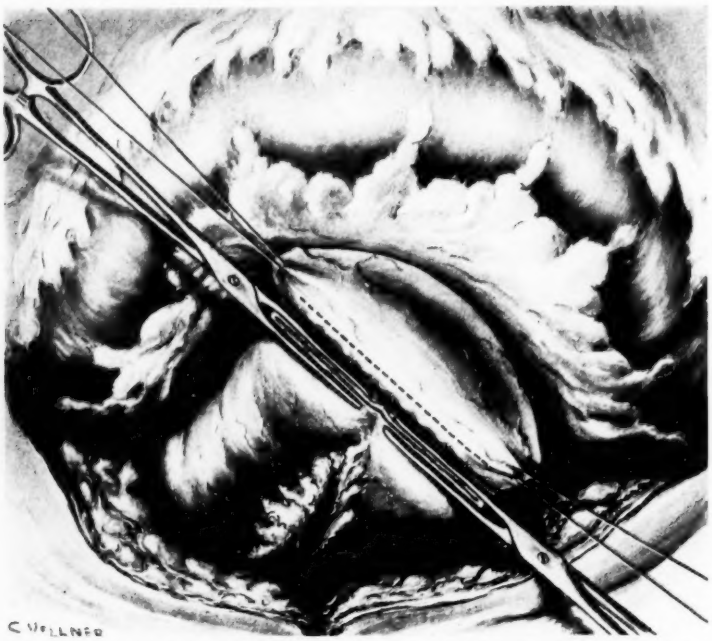

Fig. 6. The crushing clamps have been separated and the direction of the original transverse incision now runs parallel to the long axis of the intestine. The stomach and jejunum have been approximated and the posterior row of interrupted sutures has been completed. The dotted line indicates the proposed gastric incision.

It should be emphasized that there were no adhesions or permanent kinks and that the obstruction could be attributed to the "valve" formation only. These observations are in contrast to those of Cannon and Blake, who did not believe that such valves were entirely responsible for their failures but state that the development of symptoms of the so-called "vicious circle" (vomiting, gastric retention, etc.) have been associated in their experiments with kinks and demonstrable obstacles to the free passage of chyme. They pointed out that under conditions with intact circular muscle fibers sharp angulations in the intestine may be readily straightened out by the force of peristalsis.

The purpose of the present communication is to present an operation, not entirely new in principle, but, which in comparison with the older methods, develops more completely the efficiency of the transverse jejunal incision. This greater efficiency of the new operation has been demonstrated by clinical and experimental study and is ample justification for its introduction as a clinical procedure.

OPERATIVE TECHNIQUE FOR POSTERIOR GASTROJEJUNOSTOMY WITH TRANSVERSE JEJUNAL INCISION

The stomach, transverse colon, and omentum are turned upward to expose the under surface of the transverse mesocolon, as in the usual procedure. The duodenojejunal junction is located. The posterior surface of the stomach is exposed by an opening made through an avascular portion of the transverse mesocolon. The stomach is delivered and the part required for the anastomosis is located. A guide suture is inserted at either end of the proposed incision, into the stomach.

The line of the gastric incision may be selected as in the standard procedures. In the cases herewith reported the opening was made so that the stoma would lie vertically or extend from above downward and to the right, at an angle of 45 degrees with the horizontal. The exact line has been selected in each instance so that there was no rotation or kinking of the jejunum proximal to the anastomosis. The opening in the mesocolon is closed by the suturing of the cut edges to the stomach wall.

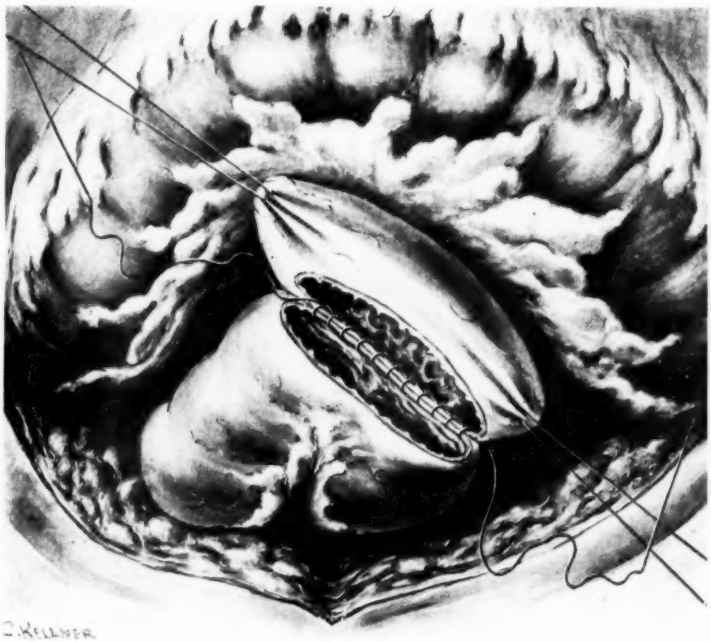

Fig. 7. The crushed edges of the jejunal opening have been excised after removal of the clamps. The continuous inner suture of catgut across the posterior half of the stoma has been completed.

The jejunum is lifted into position for a short-loop operation. A point is selected between adjacent straight intestinal arteries, and two small crushing clamps are applied side by side extending across two-thirds to three-fourths of the diameter of the intestine. A margin of ¼ inch is left at the mesenteric border (Fig. 5). After an incision is made between the clamps, their handles are separated and the direction of the original transverse incision is changed to run parallel to the long axis of the intestine. This portion of the jejunum is approximated to the stomach along the line of the proposed gastric incision so that the distal loop will lie near the greater curvature. A posterior row of interrupted silk sutures is inserted. Care is taken that the middle suture is accurately placed opposite the end of the original jejunal incision (Fig. 6). An incision is made into the stomach of the same length as the jejunal stoma (approximately 2½ inches). The bleeding is controlled with ligatures of fine plain catgut. The crushing clamps are removed, and the crushed edges of the jejunum are excised. The anastomosis may be completed in accordance with the operator's preference. The usual procedure in this series has been to commence in the middle of the anastomosis posteriorly with a No. 0 chromic catgut suture and carry it in either direction as a continuous through-and-through locked stitch (Fig. 7). This suture is continued around the angles as a continuous, inverting, mattress stitch, until the anastomosis is completely closed (Fig. 8). Care is taken to invert a minimal amount on the jejunal side and thus avoid producing an unduly large diaphragm. The anterior layer is reinforced with interrupted mattress sutures of fine black silk to complete the anastomosis (Fig. 9). On completion of the anastomosis, the stomach and transverse colon are replaced and the distal jejunal loop gravitates downward at right angles to the greater curvature in the optimum mechanical position (Fig. 10). The proximal and distal openings are each approximately the size of the cross section of the jejunum.

DISCUSSION

This communication is not concerned with a discussion of the indications for, or the therapeutic value of, gastrojejunostomy, but is limited in its

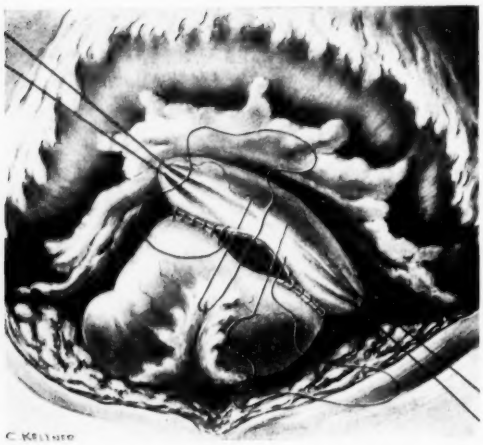

Fig. 8. The suture has been continued around either angle. This is a continuous inverting mattress stitch.

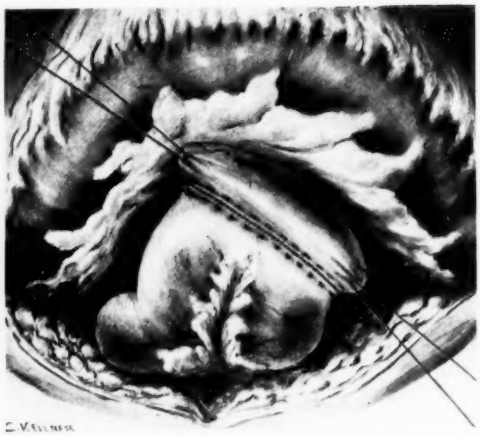

Fig. 9. The operation has been completed by reinforcing the anterior layer by a row of interrupted mattress sutures of fine black silk.

scope to a consideration of the technique, the mechanical advantages, and the results of the clinical application of a new method for making a gastro-enterostomy with a transverse jejunal incision.

Although the utilization of the transverse jejunal incision in the performing of a gastro-enterostomy is not entirely new, the older methods fall short of completely developing possibilities of the transverse incision. Mayo (5) in 1905 stated: "In June, 1903, we began the method of Mikulicz, making the opening within three or four inches of the origin of the jejunum and using a transverse incision. We made forty-three by this method with four deaths, two of which could be fairly excluded. Four required a second operation at our hands, and to a large extent because we departed from the originator's technique. It came about this way: *The transverse intestinal incision limits the size of the opening to one-half the diameter of the intestine*[1], less about one-fourth inch suture line, and the opening could seldom be made larger than would admit the invaginated thumb. We tried to enlarge this by encroaching on the bowel, and caused a valve to form, which turned the bile into the stomach. These patients gave us a lot of trouble, the short upper limb of the loop made an ordinary entero-anastomosis of the two arms of the bowel impossible. We finally united the intestine each side of the opening in exactly the same manner as in the Finney operation at the pylorus. The result was good. This was our first experience with the short proximal loop; the cases which recovered after this method have remained in splendid condition, despite the small opening."

[1] The italics are my own.

I have been unable to find the reference to Mikulicz's procedure, but assume that it is somewhat similar to the method of Kocher (4) which is illustrated in Figure 11.

According to the procedure mentioned by Mayo the size of the opening is limited to one-half the diameter of the jejunum; according to Kocher's method the length of the incision is equal to the diameter of the intestine; but in the method described in the present paper the length of the opening obtained with the transverse jejunal incision is practically *twice the diameter of the intestine* (about 2½ inches). The opening into each loop is approximately equal to the cross section of the jejunum which obviously is the maximum possible size of the *effective lumen* in any type of anastomoses even though a longer longitudinal incision into the intestine gives a seemingly larger opening.

CLINICAL APPLICATION

The operation of gastro-enterostomy with a transverse jejunal incision, according to the above technique, has been performed in 23 instances including 17 in which the procedure was utilized as the operation of choice and 6 for palliative relief of pyloric obstruction in malignant disease. The 6 cases of malignancy, on whom palliative procedures were performed, are excluded from the following discussion of results. Among the former group of patients (Table I)

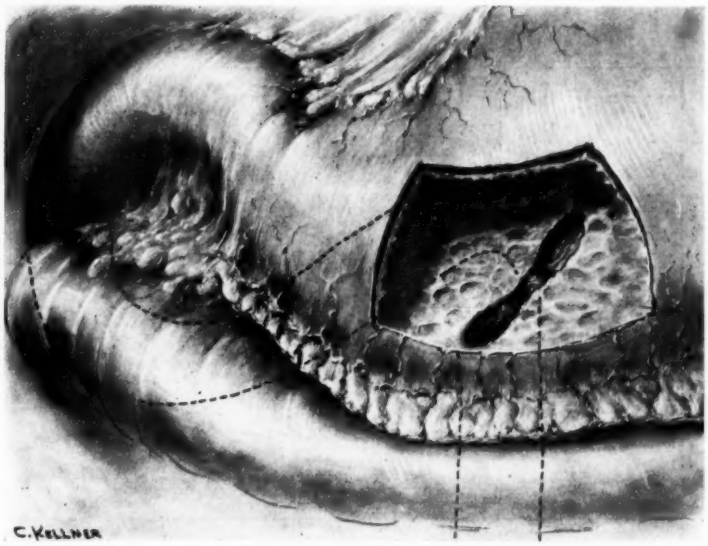

Fig. 10. The transverse colon and stomach have been replaced. The stoma (about 2½ inches long) is shown through a window in the anterior wall of the stomach. The dotted lines (diagrammatic) illustrate the position of the proximal and distal loops.

are included 11 duodenal ulcers (one following an acid burn), 3 gastric ulcers (one of which also had a duodenal ulcer), 1 gastrojejunal ulcer and 2 carcinomata of the stomach. The operative procedures include 14 posterior gastro-enterostomies, one Billroth II, one retrocolic Pólya and one antecolic Balfour Pólya. The results are given in Table I. The series is small but should represent a fair cross section of gastroduodenal lesions requiring surgical treatment.

At the present time only the immediate and early results can be adequately considered as the majority of the operations were performed quite recently and sufficient time has not elapsed for an evaluation of the remote results. However, as the advantages in the new method are probably largely mechanical, it seems unlikely that the remote results will differ from those observed following the usual procedures. The best indication of the mechanical efficiency of a gastro-jejunal anastomosis is the frequency of the occurrence of postoperative vomiting and prolonged gastric retention.

The immediate convalescence has been surprisingly uneventful in the entire series. There was no postoperative vomiting whatever in 11 of the 17 cases; in 5 there was slight vomiting following the operation but complete relief was obtained after gastric lavage. In one case only slight vomiting persisted off and on while the patient remained in the hospital.

The functional efficiency of the anastomosis has also been studied by routine fluoroscopic examinations of the stomach shortly before the patients were discharged from the hospital, and at later intervals between 2 and 9 months after the operation. In a discussion of the immediate postoperative roentgenograms, it is necessary to emphasize the fact that a moderate amount of gastric residue is very frequently observed after the orthodox posterior gastro-enterostomy. This usually disappears after a few weeks and, accordingly, the occurrence of gastric stasis after 6 hours is not significant unless of extreme grade or unless it persists for a long period after operation. In the present series there was no 6 hour gastric residue in the immediate postoperative roentgenograms in 7 instances; in 8 there was slight retention; and in 2 there was a marked gastric residue. There was no 6 hour residue in 13 patients on whom subsequent roentgenographic examinations were made at intervals between 2 and 9 months after operation. Of the remaining four patients, one is free of all gastric symptoms (no X-rays obtained), one is dead, and two cannot be located.

Although the occurrence of symptoms of the so-called "vicious circle" have been largely pre-

TABLE I.—GASTRO-ENTEROSTOMY WITH TRANSVERSE JEJUNAL INCISION

Duodenal Ulcers

Case	Age Sex	Duration of Symptoms	Operation		Postoperative Results	
			Findings	Procedure	Immediate	Early
M. G	36 M	8 yr.	Duodenal ulcer with almost complete cicatricial stenosis of pylorus	4–28–26. Posterior gastro-enterostomy with transverse jejunal incision	No nausea or vomiting. X-ray, 5–21–26. Very slight 6 hr. retention. Discharged 27 days after operation	12–3–26, 6 mos. after operation. Has gained 50 lbs. Symptoms relieved. No 6 hr. stasis.
G.R.	67 M	10 yr.	Duodenal ulcer with recent hæmorrhage. Duodenum fixed to under surface of liver by dense adhesions	6–12–26. Posterior gastro-enterostomy with transverse jejunal incision	The patient vomited several times on day following operation. Gastric lavage gave complete relief. X-ray, 6–25–26. Very slight 6 hr. stasis. Discharged 17 days after operation	11–29–26. 5½ mo. after operation condition good. Relief from symptoms. X-ray: No 6 hr. stasis.
W.K.	65 M	2 mo.	Cicatricial stenosis of pylorus following acid burn	11–6–26. Posterior gastro-enterostomy with transverse jejunal incision	No nausea or vomiting. The patient developed urinary retention requiring an in-lying catheter. Developed bilateral thrombophlebitis of saphenous veins. While under treatment for infection of urinary tract, left hospital against advice, 1–14–27	1–14–27, 9 wks. after operation. X-ray: No 6 hr. retention.
T.S.	36 M	1 yr.	Ulcer on posterior wall of duodenum	12–21–26. Posterior gastro-enterostomy with transverse jejunal incision	No nausea or vomiting. X-ray, 1–6–27. Very slight 6 hour retention. Discharged 17 days after operation	Unable to locate patient.
F.B.	33 M	1 mo.	Probable perforated duodenal ulcer. Adhesions with fixation of duodenum to under surface of liver	1–3–27. Posterior gastro-enterostomy with transverse jejunal incision	Slight vomiting on 2nd and 3rd days. No further nausea or vomiting following gastric lavage. X-ray: No retention after 6 hrs. Discharged 20 days after operation	9 mo. after operation, condition good. Feels much better. Sensitive spot in epigastrium X-ray, 9–16–27. No tenderness over stoma. No 6 hour retention.
T.W.	52 M	4 yr.	Duodenal ulcer with partial cicatricial stenosis	2–9–27. Posterior gastro-enterostomy with transverse jejunal incision	The patient vomited small amounts off and on throughout his stay in the hospital. No discomfort. Taking soft diet. 3–2–27. X-ray shows considerable 6 hr. retention. Discharged 23 days after operation	7½ mos. after operation. The patient has moved to another city. A follow-up letter stated that he was feeling well and did not complain of gastric symptoms.
H.L.B.	45 M	4 yr.	Cicatricial pyloric stenosis with duodenal ulcer	4–13–27. Posterior gastr›enterostomy with transverse jejunal incision	No nausea or vomiting. Complete relief from symptoms. No X-rays. Discharged 21 days after operation	9–12–27. 5 mo. after operation. Complete relief of symptoms. Has gained 15 lbs. No 6 hr. retention.
P.L.	60 M	2 yr.	Perforated duodenal ulcer. Fibrous and fibrinous adhesions between duodenum and liver	5–10–27. Posterior gastro-enterostomy with transverse jejunal incision	Vomited small amounts 1st and 2nd days. No further vomiting following gastric lavage. X-ray: 5–21–27. Very slight retention after 6 hr. Discharged 19 days after operation	2½ mo. after operation; condition good. Symptoms relieved. Has gained weight. No 6 hr. residue.
M.M.	52 M	20 yr.	Duodenal ulcer with cicatricial stenosis of pylorus	7–26–27. Posterior gastro-enterostomy with transverse jejunal incision	No nausea or vomiting. 8–15–27 X-ray: slight 6 hr. stasis. No gastric symptoms. Discharged 20 days after operation	5½ mo. after operation. Condition good. Symptoms relieved. Gained 20 lbs. No 6 hr. residue.
M.L.	48 M	20 yr.	Duodenal ulcer with cicatricial stenosis of pylorus. Complete occlusion	8–2–27. Posterior gastro-enterostomy with transverse jejunal incision	No nausea or vomiting. Complete relief of symptoms. 8–19–27 X-ray: some 6 hr. residue. Discharged 17 days after operation	5 mo. after operation. Condition good. Symptoms relieved. Gained 30 lbs. No 6 hr. residue.
M.D.	26 F	2 mo.	Duodenum adherent to liver. Probable duodenal ulcer	8–3–27. Posterior gastro-enterostomy with transverse jejunal incision	Slight vomiting for 3 days. Relief after gastric lavage. 8–26–27. X-ray: some 6 hr. residue. Discharged 23 days following operation	5 mo. after operation. Has vomited occasionally. No pain. General condition good. No 6 hr. residue.

Gastric Ulcers

W.W.	55 M	10 yr.	Large adherent gastric ulcer on lesser curvature with almost complete pyloric occlusion	4–13–26. Posterior gastro-enterostomy with transverse jejunal incision. 4–29–26. Partial gastrectomy. Gastro-enterostomy stoma in good condition	No nausea or vomiting. 5–7–26, 24 days after the first and 8 days after 2nd operation patient developed pneumonia. 5–8–26, patient died.	

TABLE I.—GASTRO-ENTEROSTOMY WITH TRANSVERSE JEJUNAL INCISION (Continued)

Case	Age Sex	Duration of Symptoms	Operation		Postoperative Results	
			Findings	Procedure	Immediate	Early
Gastric Ulcers (Continued)						
C.A.	52 M	8 yr.	Gastric ulcer. Posterior wall and duodenal ulcer with partial pyloric stenosis	3-24-26. Partial gastrectomy. Posterior gastro-enterostomy with transverse jejunal incision. (Type: Billroth II)	No nausea or vomiting. Condition good. X-ray, 4-9-26; slight 6 hr. stasis. Discharged 16 days after operation	12-4-26. 8 mos. after operation. Symptoms relieved. Gained in weight. X-ray: No 6 hr. stasis.
E.S.	44 F	Several years	Ulcer in pyloric portion of stomach with partial pyloric stenosis. Marked gastroptosis	1-28-27. Posterior gastro-enterostomy with transverse jejunal incision. Patient's condition precluded a resection	No nausea or vomiting. 2-16-27, X-ray: Considerable stasis after 6 hr. Discharged 19 days following operation	3-19-27. General condition good. No untoward symptoms. 9-13-27, 8½ mos. after operation. General condition good. Occasional slight distention. No nausea or vomiting. X-ray: No 6 hr. residue.
Gastrojejunal Ulcers						
C.G.	39 M	10 yr.	Gastrojejunal ulcer at site of gastro-enterostomy. Mass adherent to transverse colon	9-22-26. Excision of old gastro-enterostomy with jejunal ulcer. End-to-end anastomosis of jejunum. Gastro-enterostomy with transverse jejunal incision‡	No nausea or vomiting. Symptoms relieved. 10-12-26. X-ray: No 6 hr. stasis. Discharged 20 days after operation	Unable to locate patient.
Gastric Carcinomata						
J.L.	67 M	18 mo.	Carcinoma pyloric portion of stomach with partial occlusion of pylorus	4-13-25. *Partial gastrectomy. Gastro-enterostomy with transverse jejunal incision. (Antecolic Balfour-Pólya)	No postoperative nausea or vomiting. 5-7-25, X-ray: No 6 hr. residue. Discharged 24 days after operation	10 months after operation. Patient gradually declined. No nausea or vomiting. Died 2-17-26.
A.R.	67 F	5 yr.	Carcinoma of pyloric portion of stomach with partial pyloric occlusion	10-21-26. Partial gastrectomy. Posterior gastro-enterostomy with transverse jejunal incision. (Retrocolic Pólya)	No nausea or vomiting. 11-10-26, X-ray: No 6 hr. residue. Discharged 21 days after operation	3-29-27, 6 mos. after operation; no evidence of recurrence. X-ray: No 6 hr. residue.

*An entero-enterostomy was made between the proximal and distal jejunal loops.
‡The condition of the patient contra-indicated a partial gastrectomy.

vented by the general adoption of the posterior no loop procedure, not infrequently postoperative vomiting is a disturbing complication. These symptoms have been attributed to a variety of factors including, improper placing of stoma, adhesions, kinks or twists, etc., but it is quite possible that the valve formation observed experimentally (*vide supra*) may be among the more important exciting causes. The severed muscle fibers can have no effect on the forward movement of food, as their contraction will merely shorten the intestinal wall opposite the gastric opening. The course of events may be that the stomach becomes distended with partial valve formation and when this condition is once established, unless it is relieved by the complete emptying of the stomach, will tend to become gradually worse by the accumulation of the normal secretions or by the continued ingestion of food and water. There is clinical evidence of the correctness of this hypothesis in that the majority of such patients are relieved by gastric lavage which prevents further dilatation of the stomach until the normal muscle tonus is restored. One of the chief advantages of the transverse jejunal incision lies in the fact that gastric distention has no tendency to the formation of a valvular obstruction, but on the contrary maintains the patency of the stoma.

SUMMARY

1. The division of the circular muscle fibers by the longitudinal jejunal incision is responsible for the faulty mechanics of the usual side-to-side gastrojejunostomy.

2. A method of performing a gastro-intestinal anastomosis is presented whereby the jejunum is incised transversely rather than longitudinally in order to avoid the mechanical defects inherent in the division of the circular fibers.

3. The theoretical advantages of this procedure are several: The circular muscle fibers are not severed and accordingly there is a minimal interference with peristalsis, the intestinal loops

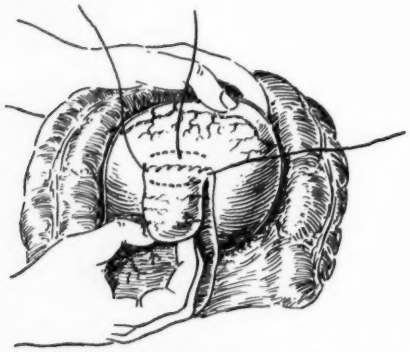

Fig. 11. Kocher's method for gastro-enterostomy with transverse jejunal incision. "The jejunum has been sutured to the stomach. The center of the three threads represents the upper end of the suture uniting the jejunum and stomach in the vertical direction. The two lateral threads are the ends of the posterior serous suture of the anastomosis. The dotted lines on the stomach and intestine show the direction of the anastomotic opening, which is transverse to the long axis of the jejunum and equal to its diameter."

(From Kocher, T.: Text-book of Operative Surgery, 1911, vol. ii, p. 575.)

gravitate downward, without kinking, into the ideal mechanical position, and finally distention of the stomach has no tendency to produce a valvular obstruction but on the contrary maintains the patency of the lumen.

4. In previous reports of experimental studies (6 and 7) a practical demonstration of these theoretical advantages has been made. These experiments included a comparison between the usual gastrojejunostomy with a longitudinal jejunal incision and the new method with a transverse jejunal incision. In a series of 10 dogs, the new procedure proved to be mechanically and functionally satisfactory. In contrast, a comparable series of ten gastrojejunostomies with the usual longitudinal jejunal incision resulted in 3 cases of obstruction due to the formation of "valves." The remaining 7 animals in this group remained in excellent condition.

5. The results of the clinical application of gastro-enterostomy with a transverse jejunal incision, according to the technique described in the present paper, are presented. The immediate and early postoperative results have been exceedingly excellent in these patients. The remote results will be presented in a subsequent communication.

REFERENCES

1. Cannon, W. B., and Blake, J. B. Gastro-enterostomy and pyloroplasty. Ann. Surg., 1905, xli, 686.
2. Case, J. T. Roentgen studies after gastric and intestinal operations. J. Am. M. Ass., 1915, lxv, 1628.
3. Kelling, G. Studien zur Chirurgie des Magens. Arch. f. klin. Chir., 1900, lxii, 1.
4. Kocher, T. Text-book of Operative Surgery, 1911, ii, 575.
5. Mayo, W. J. A review of five hundred cases of gastro-enterostomy, including pyloroplasty, gastroduodenostomy, and gastrojejunostomy, 1905, xlii, 641.
6. Moise, T. S., and Harvey, S. C. A method for an end-to-end gastrojejunostomy after a partial gastrectomy. Surg., Gynec., & Obst., 1925, xl, 559.
7. Moise, T. S., Haagensen, C. D., and Vogt, E. C. A method for gastro-enterostomy with a transverse jejunal incision. Surg., Gynec., & Obst., 1927, xliv, 824.

SUPRARENAL APOPLEXY, BILATERAL

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HÆMORRHAGE into the suprarenal gland is not infrequently found in infancy. It is, however, a rare condition in the adult. Our attention has been recently focused upon this subject by a case of an acute destructive hæmorrhage affecting both suprarenal glands in an adult, which, despite its great rarity, is of unusual interest.

The patient, an American merchant of 45 years, was seen in surgical consultation by one of us. His family history was unimportant. He had gonorrhœa in youth. Six years ago he had an indefinite abdominal condition at which time no physical signs were apparent. Two years ago he was treated for a left, dry, diaphragmatic pleurisy which cleared up rapidly. In August, 1924, he was under the care of one of us for a phlebitis of the right leg, which caused marked swelling of the extremity, out of all proportion to the pain and tenderness to pressure, which were conspicuous by their absence. Serological investigation of his blood revealed a triple plus Wassermann. He was given a thorough course of antisyphilitic treatment to which the phlebitis reacted well, but the right extremity always remained slightly larger than the left.

On Sunday, September 26, 1926, the patient was in normal health and played golf. Monday at breakfast he claimed that he never felt better. While engaged at his office duties at 10:30 a. m. he was suddenly seized with a severe "tearing" pain in the right kidney region, which did not radiate.

Dr. Meininger, the family physician, was immediately called. He made a thorough physical examination, which was negative. There was no tenderness or rigidity of the abdomen. The temperature and pulse were normal. The urine showed a few red blood cells. Because of the location of the pain and the red cells in the urine, and because of the absence of any other localizing signs, a tentative diagnosis of renal calculus was made and morphine administered, with relief. On September 27 and 28 he had many severe attacks of excruciating pain of the same character, always directed to the right side of the back and under the ribs. His condition was carefully watched, yet no new evidence presented. On September 29, the urine was again found to contain a few red cells. Physical examination showed slight tenderness to deep pressure in the region of the gall bladder, but there was no rigidity. The temperature and pulse still remained normal; the blood count was within normal limits.

On September 30 and October 1 the patient was free of symptoms and so markedly improved that he was considered out of danger. On October 2, however, he began for the first time to have severe non-radiating pain in the *left* kidney region and under the left ribs in front. His temperature rose to 99.8 degrees, pulse to 84. The pain persisted in both sides and was so severe that he passed a poor night with only a few hours' relief from morphine, one-half grain, administered hypodermically. On October 3, he looked bad. His pulse rate was 90, his temperature 100 degrees. There was tenderness to pressure a few finger-breadths below the ribs and also in the kidney region. There was no extreme tenderness, no rigidity, and no new physical signs to assist in determining the nature of this sudden turn. He was removed to the hospital. The white blood cells numbered 16,600, with 69 per cent polymorphonuclears. The hæmoglobin was 86 per cent, erythrocytes 4,410,000. The urine again showed a few red cells. X-rays of the abdomen showed a shadow in the course of the right ureter, which strongly supported the clinical impression. The diagnosis of the roentgenologist was "stone in the right ureter."

On October 4, the patient was slightly improved. The pain became more generalized over the upper abdomen, but was always worse on the right side; there was no rigidity. That evening the temperature rose to 102.2 degrees, pulse 90 and weak. Later that night he had more pain and morphine was given quite freely. The patient became mentally dull. He was examined carefully on several different occasions that day, but no new evidence was unveiled.

Dr. Meyer was called to give more expert advice on the urological condition. The next morning, October 5, he investigated the genito-urinary tract with cystoscope and X-ray and reported definitely that the shadow previously thought to be a calculus in the ureter was definitely outside that structure. The urine from the bladder and both ureters was clear. He was firmly convinced that there was no abnormality of the genito-urinary tract. At this point one of us was called to consult with Drs. Meininger and Meyer to determine if possible whether a surgical condition was present.

When seen for the first time on October 5, the patient looked very sick and was in the midst of a distressing chill. He had been cystoscoped that morning by Dr. Meyer and was under the influence of morphine. He was in no condition to be examined thoroughly. His blood leucocytes numbered 11,600, with 67 per cent polymorphonuclears. The temperature rose to 102.4 degrees, pulse to 120. The urine contained a slight trace of albumin. The patient was mentally dull (he was usually very acute mentally).

The next morning, October 6, he was seen again with Drs. Meininger and Meyer. The patient was mentally obtuse, not able to express himself. In the midst of a question, he would turn over on his side and apparently go to sleep. The temperature was 104 degrees, pulse 130. The tongue was coated. He complained of pain in the right side high up under the ribs. The abdomen was slightly distended. The right rectus was a little guarded in its upper portion. There was tenderness to pressure in the gall bladder region, but there was no tenderness at this time in the right or left costovertebral angles. He complained of pain along the vertebræ between the scapulæ. With the tenderness and slight rigidity in the right upper quadrant, acute cholecystitis was considered; also we thought of a long retrocæcal appendix deep in the flank. The findings, however, were so atypical that we did not feel justified in operating. The white blood cells were 16,000 with 69 per cent polymorphonuclears. Spinal puncture gave no further information. The blood Wassermann was 2 plus

The patient was seen several times that day but there were no new findings. We came more and more to believe that this was a very unusual condition that would present such a picture, and the possibility was considered of hæmorrhage into a retroperitoneal tumor with secondary necrosis. We had seen deeply placed tumors of this character, difficult to diagnose and slow growing, in which a similar accident occurred. A very remarkable case was

Fig. 1. Gross appearance on section of the right suprarenal gland, showing the massive hæmorrhage with complete destruction of the medulla and almost complete destruction of the cortex. The remaining golden rim of cortex, itself the seat of profound destruction and hæmorrhage, is shown. One also sees the ecchymotic capsule.

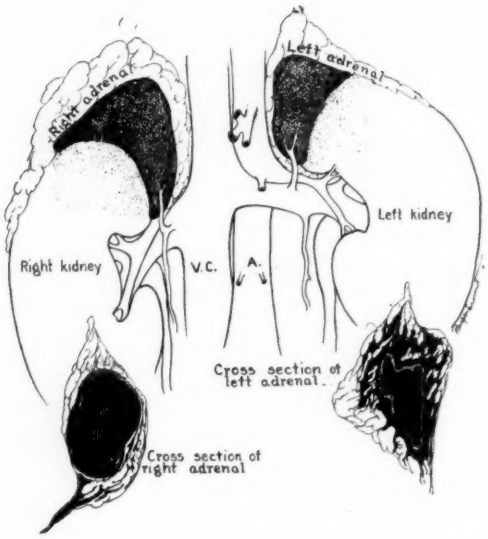

Fig. 2. Gross appearance and relations of the suprarenal glands in the case reported. Both glands were destroyed by massive hæmorrhage.

called to mind of a boy of 17 years who had an enormous retroperitoneal hæmorrhage from rupture of a vessel on the surface of a hypernephroma. For over a year the tumor was unrecognized. We also considered an unusual thrombosis or aneurism of a deep-seated vessel. We were so uncertain by evening that Dr. Moffitt was called.

On October 7, Dr. Moffitt consulted with us. We found the patient mentally dull, incoherent, profoundly asthenic, depressed out of all proportion to the temperature, blood count and physical findings. The pulse was rapid in contrast to the rather low grade fever, but the blood pressure was 120—80 and there were no obvious signs of circulatory failure. He preferred to lie on his back. The nurse had noted that being on the right side caused distress and occasional hiccough. There were no causes above the diaphragm to account for the general condition or abdominal symptoms. The abdomen was much less rigid and distended than on the day before. Aside from considerable tenderness deep in the right hypochondrium and less marked tenderness along the course of the pancreas, nothing was found; no rigidity front or back, no œdema of belly wall, no localized vein distention, no discoloration of umbilicus, no tremors, etc. Myomalacia cordis was particularly considered on account of weakness, delirium, fever, and early leucocytosis, but the initial and subsequent pain were incompatible. It was evident that we were dealing with no ordinary involvement of appendix, gall bladder, or stomach. Pancreatitis was more seriously considered but the localization of the initial pain, the lack of early collapse, cyanosis, or gastro-intestinal symptoms were so much against it as to rule out thought of surgical treatment. Radiculitis of syphilitic origin or encephalitis were likewise considered but abandoned for lack of further evidence. The history of syphilis, of previous unexplained left-sided pain, and of an unusual right femoral vein thrombosis suggested the possibilities of abdominal aneurism with retroperitoneal hæmorrhage, or some unusual intra-abdominal thrombosis or hæmorrhage.

On October 8, the mental symptoms became more pronounced and the weakness more marked. At this time we all concluded that deep hæmorrhage rather than infection had occurred, and that no help could be expected from surgery. The hæmatoma probably lay retroperitoneally, probably not connected with the pancreas. Adrenal hæmorrhage was considered as a possibility, as was also hæmorrhage into a hypernephroma or from an aortic or cœliac axis aneurism. The patient's blood pressure fell to 90 and then to 60 and he became extremely difficult to arouse. The respirations climbed to 40 and then to 55, with periods of Cheyne-Stokes type. The pulse became very rapid and then imperceptible. Death occurred on October 8, 1926, 12 days after onset of symptoms. At postmortem examination both suprarenal glands were found to be enlarged, the seat of massive hæmorrhage which destroyed the entire architecture of the gland, sparing only a small, gold-brown rim of cortex about 1 millimeter wide (Figs. 1 and 2). The further details of the pathological picture are noted in the report of Dr. G. Y. Rusk as follows:

Anatomical diagnosis. Bilateral hæmorrhage into adrenals. Chronic obliterative pleurisy on right. Chronic adhesions about spleen and upper surface of liver.

The spleen is increased to twice its normal volume, is slightly reduced in consistency; and on section is somewhat pale. The Malpighian bodies are obscure, otherwise negative. The liver except for the adhesions noted above appears negative superficially and on section. The gall bladder appears somewhat grayish and slightly thickened. The pancreas appears negative. The splenic artery is tortuous and shows slight thickening of the wall.

The kidneys are of normal size. The capsule strips readily leaving a clean surface. On section, the right kidney appears negative. The left appears negative so far as the cortex and medulla are concerned, but the pelvis is filled with a clot. In normal relation to the kidney are the two adrenals, both markedly enlarged (Figs. 1 and 2). The enlargement is more or less diffuse and the general outline of the organs are preserved except for the general enlargement. On section, the right adrenal shows an extensive hæmorrhage, the blood of which is clotted, which in part separates the two sides of the adrenal and in part suffuses

into the fat subjacent to it. The clot in this organ is partly broken down. The left adrenal presents the same picture of hæmorrhage. Here the mass is contained practically entirely within the organ. In only the upper pole has it broken into the surrounding tissue. Here the clot is firm to the touch. Definite thrombosis of the central vein is not made out grossly.

Microscopic examination. Microscopic examination made of sections from the various viscera are all essentially negative except for sections of the kidney and adrenals. Microscopic examination of sections of the kidneys shows in the fibrous capsule several rather sizable accumulations of lymphocytes and slight hæmorrhage. In the superficial layer of the cortex just beneath the capsule and in several points of the medulla, there are discrete focal accumulations of lymphocytes. A number of sections were taken from each adrenal (Fig. 3), and sections from such tissue shows the hæmorrhage in the medullary portion of the adrenals extending to various degrees into the peripheral fat. In addition a number of larger veins show thrombotic occlusion. There is no evidence of any new-growth associated with the process. There is also no evidence in the histology that any infectious process was present. Further it should be noted that microscopic as well as the gross findings fail to give indication as to the etiology of the process.

One wonders, in retrospect, whether the vague abdominal symptoms of 6 years ago were associated with transient disturbances of the suprarenal glands, possibly a small hæmorrhage, which was finally absorbed. It is apparent according to the symptoms, that in the attack which caused his death, the right gland was involved first and the left gland followed some days later.

This type of profuse hæmorrhage into both suprarenal glands must be differentiated from the small diffuse ecchymoses and hæmorrhagic spots of toxic origin occurring during acute infectious diseases. Small toxic ecchymoses are frequent; massive hæmorrhages are rare in children, extremely rare in adults.

In 1906, Lavenson published an exhaustive yet concise review of the entire subject of acute adrenal insufficiency up to that time. Since then there have been few publications of note in English; but among the Germans the works of Lissauer (1908), Materna (1910), Kempf (1918), Freudemann (1920), Fraenkel (1923), and Brasser (1924) must be mentioned as worthy contributions. Since 1906, 20 cases of bilateral suprarenal apoplexy in adults have been reported by Munson, Laederick, Garipuy and Schreiber, Lissauer, Hektoen, Brodnitz, Ellis, Valentin, Weidman, Foster, Freudemann, Michaux and Marsset, Fraenkel, Brasser, Kessel, Bittorf and Severn.

When we search for etiological factors we are struck by the great number of theories advanced, which indicates, in a way, the unsatisfactory state of our knowledge. In tracing the various factors, one is tempted to turn to the period at which the condition is more frequent; namely, in the newborn and in childhood. Kempf calls attention to the embryology of these sensitive glands

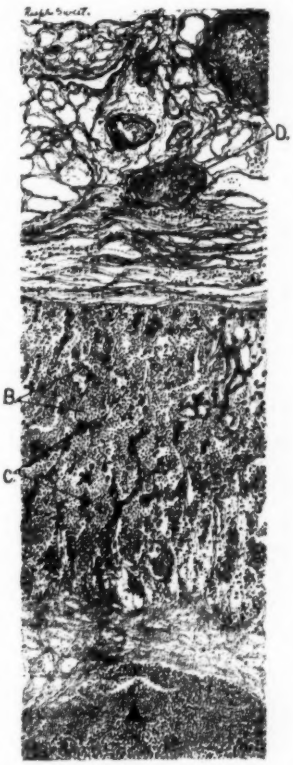

Fig. 3. Microscopic section of affected adrenal. The medullary portion *A* is occupied by a large blood clot which has destroyed all evidence of medullary tissue. In the cortex one sees marked hæmorrhagic infiltration, *B*, with destruction of most of the cortical cellular elements with the exception of a few scattered cell columns *C*. In the peri-adrenal fat one sees thrombosis of the vessels in early stages of organization *D*. Low power.

as a predisposing factor in the young. The fusion of the interrenal (cortical) and the adrenal (medullary) anlagen into a single organ takes place very gradually and reaches its full development between the end of the first year and the cessation of growth. In intra-uterine life what is to be the suprarenal gland consists only of interrenal tissue, in which only a few sympathetic elements are included. The newborn adrenal shows an outer layer, consisting entirely of cortex; and an inner layer, broader and darker, filled with blood, consisting mostly of cortex except for small complexes of medullary cells dispersed about the veins. In the first month there occurs marked capillary hyperæmia of the inner layer and associated therewith a beginning degeneration of the

cortical cells. From the second month to the twelfth month the hyperæmia is marked, and there occurs further fatty, vacuolar, and colloid degenerative changes in the cortical cells, the place of the atrophic cells being taken by the medullary cells which ever increase in number as if being able to withstand the pressure of the hyperæmia to which the cortical cells succumb. This process persists to the cessation of growth, and evidence of it is even found in adult suprarenals. It is this hyperæmia and destruction which Kempf claims is the most important predisposing factor in adrenal hæmorrhage in the young and may also play a part in adults.

The trauma and circulatory disturbances incident to labor have often been suggested as causes in the newborn, yet suprarenal hæmorrhage is known to occur in cases in which the delivery has been exceptionally quick and easy, and there are a great number of extremely difficult labors in which these glands have remained intact. Some have also suggested the resuscitation methods of Schultz to be responsible, but this has been disproved.

In adults many conditions have been advanced as having an etiological bearing. Among these are thrombosis, capillary emboli, congestive diseases, infections and toxins, diseases of the solar plexus, surface burns, and hæmorrhagic diathesis. Simmonds reported 7 cases occurring during the course of chronic diseases in the viscera, in all of which the suprarenal veins were found to be thrombosed.

Lavenson reports the finding of only two cases of acute adrenal insufficiency in which hæmorrhage or necrosis were not responsible; one case in which there were abscesses of both suprarenals and the other in which there was suppuration of both suprarenals in a case of Pott's disease. He reports a case in which thrombosis was evidently the causal factor and suggests that regional suppuration may, in some cases, cause thrombosis of the suprarenal veins. Thrombosis of the small vessels was also noted by us in our own case, but the large vein was free. With Simmonds, Lavenson, Brasser, Kempf, and others, we agree that thrombosis is the most important etiological factor in the production of hæmorrhage and necrosis of both adult suprarenal glands. In some cases, thrombosis may produce a marked infarction, in others only a lesser degree of hæmorrhagic infiltration. Simmonds claims that this depends upon the occasional presence of a row of accessory suprarenal veins, which empty into the diaphragmatic veins and are variable in size and number.

Simmonds noted in the cases reported by him that the thrombi in the central veins and large branches were definitely older than those in the small branches and capillaries, and concluded therefore that thrombosis was necessarily the primary causal factor in these cases, the hæmorrhage being secondary. Were hæmorrhage the primary phenomenon, the older thrombi would occupy the smaller vessels, the larger branches and central vein would be the seat of fresh thrombi or be entirely free of them. Lissauer and Ellis, in reporting similar cases, accept these views.

Some writers have suggested a relation between the production of hæmorrhage and the somewhat unusual vascular anatomy of the suprarenal glands. Lavenson and others direct our attention to the fact that the arterial supply, coming as it does from three sources, is unusually great, and that the blood after traversing the medulla, leaves at the hilus by a single large, thin vein which empties on the right into the vena cava and on the left into the renal vein. He and others have also noted that the medulla is much more frequently and profoundly affected, and that the right suprarenal is much more often the seat of hæmorrhage than the left. Lavenson suggests that simple alterations of blood supply or blood pressure may, therefore, be determining factors in the production of hæmorrhage, especially in the newborn. Kempf and Brasser, even as late as 1924 in noting the peculiarities of the vascular anatomy, suggest that the slowing of the blood current may predispose to thrombus formation in which Brasser thinks infection may play a part.

That any consideration of a purely anatomical nature may have an etiological relationship is unlikely in a condition of such extreme rarity; yet, considering that hæmorrhage has already taken place, the anatomical peculiarities may determine the overwhelming participation of the medulla over the cortex and the right side over the left, both as to incidence and extent of involvement.

Arnaud, Churton and Dudgeon have reported cases in which suprarenal apoplexy was associated with severe surface burns and some have suggested an etiological relationship between the two conditions. Simmonds feels that some other cases were the result of an hæmorrhagic diathesis. Virchow claims that diseases of the solar plexus are responsible. In those cases which are associated with convulsions, Lavenson suggests that the convulsions may have produced the hæmorrhage rather than the hæmorrhage the convulsion. Brasser and others suppose that there

may be a constitutional defect in the blood vessels which predisposes to thrombosis.

Dudgeon has arbitrarily divided cases of suprarenal hæmorrhage into three groups depending upon the degree of involvement. In the first group the whole glands are converted into blood sacs with occasional extravasations into the surrounding tissue; our own case fell into this group. In the second group, there is a well marked hæmorrhage into the medulla, the cortex being spared except for a few erythrocytes scattered between the columns of adrenal cells. These two groups are often associated with thrombosis of the suprarenal veins, and when both glands are affected, are usually fatal. In the third group, there is scattered hæmorrhage into the gland substance, chiefly in the medulla, with little or no destruction of parenchymatous elements. This last type is most frequently noted in the acute infectious diseases, is not usually the cause of death, and is not included by us in the class of "suprarenal apoplexies."

That the hæmorrhage beings in the medulla is noted by many writers. The cortex is secondarily involved, possibly by compression. The relation between these facts and the vascular anatomy has been previously noted.

It is interesting to note that suprarenal blood tumors of enormous sizes have been reported. These, however, are unilateral findings, the other gland usually being intact. Roger reported a case in which there was a blood cyst of 2 kilograms produced by hæmorrhage into a suprarenal gland; Carrington found suprarenal blood cysts the size of oranges. Routier described the case of a man of 32 years who complained of epigastric pain and vomiting of 3 years' duration, in which a 1600 gram suprarenal cyst containing changed blood was found. Pawlock notes a suprarenal cyst of 10 liters, Chiari a 3 pound cyst. Such large tumors, however, are not found in cases of bilateral suprarenal apoplexy.

Arnaud recognized three arbitrary clinical groups. The first is the so-called *peritoneal type* in which there is usually sudden, severe abdominal pain and profound collapse, associated with vomiting, moderate abdominal distention, and mild lumbar and epigastric tenderness. The picture may resemble acute hæmorrhagic pancreatitis, peritonitis, or ileus; yet the physical signs are vague and the shock is out of all proportion to them. The collapse usually goes on to coma, and the patient dies in a few days in profound depression. Such a picture has lead to surgical interference, as was deemed the procedure of choice in the case of Brodnitz who found nothing but three portions of contracted and anæmic small intestines, each 10 to 20 centimeters long. At the autopsy the essential pathology was located in both suprarenal glands. Brasser, Materna, and others consider the abdominal symptoms to be due to the abnormal epinephrine content of the blood, and to vary according to whether it is increased or diminished, and Pende thinks that they are due to disturbances of the solar plexus.

In the second type called the "*asthenic*" *type*, asthenia is the only symptom of note, progressing to a fatal termination.

In the third type the *nervous* symptoms dominate the clinical picture. There may be delirium, coma, convulsions, or a typhoid-like state.

To these types Lavenson has added a fourth, which includes cases of sudden death in which nothing is found postmortem but suprarenal destruction; and a fifth, comprising those cases which are associated with purpura of the viscera and skin. Virchow suggests that the initial sudden increase in blood pressure may tear a vessel previously damaged by bacteria or toxins and thus produce the so-called purpuric spots; he suggests too that any sudden disturbance of the medulla oblongata may be a primary cause. Foster considers the purpuric spots as another manifestation of an overwhelming infection.

Any combination of symptoms may form the clinical picture, but asthenia is the most constant and characteristic of all symptoms.

Materna (1912) claims that the symptoms of suprarenal hæmorrhage are caused by autointoxication with adrenalin which, during the profound disturbance, is thrown into the blood stream in large amounts. Hyperadrenalæmia was found postmortem in one of his cases by the use of certain tests. In one test a specimen of blood collected from that flowing spontaneously from the liver produced prompt mydriasis on the living and on the isolated eye of the frog. In another, the presence of adrenalin in large amounts was demonstrated by the action of ½ per cent ferric chloride solution on frozen liver sections and on blood serum; in these, the liver cells and the serum took on a green tint characteristic of adrenalin. These findings were checked with test solutions of 1:1000 adrenalin chloride and by chemical analysis. He suggests that when hæmorrhage occurs in a suprarenal gland rich in cholin, this product, the antagonist of adrenalin, may also be thrown into the blood stream and neutralize in whole or in part the effects of the adrenalin. Thrombi in the large

veins may prevent or delay the absorption of the liberated adrenalin. Materna claims that adrenalin poisoning rather than suprarenal failure is the cause of death. This view seems to take support from the reported cases of sudden death occurring in unilateral suprarenal apoplexies in which the remaining suprarenal gland is found intact.

An increased epinephrine content in the postmortem blood of a patient who is known to have had a massive hæmorrhage into both suprarenal glands is somewhat suggestive but by no means conclusive that a similar condition was present during life. This finding was not by any means constant in the cases reported by Materna, all of which were in children. The difficulty of making a diagnosis before death is responsible for the lack of data regarding the epinephrine content of the blood during life. If it can be determined that hyperadrenalæmia exists in the living subject, this fact would have an important bearing on the diagnosis.

Brasser, too, considers that the symptoms are due to variations in the adrenalin content of the blood. The hæmorrhage and the pressure, he claims, cause an increased flow of adrenalin into the blood with all the symptoms of hyperadrenalæmia; this condition, however, is only transient, since adrenalin is rapidly destroyed in the body and its source being curtailed, the picture changes to one of progressive hypoadrenalæmia which terminates in death.

Many other clinicians have assigned the dominant rôle in the production of symptoms to variations in the epinephrine output, and it is a general impression that a marked diminution of epinephrine is of a serious import, its total suppression a calamity, with a definite train of symptoms.

Like many other clinical impressions, these are not supported by experimental data. On the contrary, physiologists have been unable to produce experimentally any well-characterized symptoms associated with partial suprarenal insufficiency, and there is no evidence to show that diminution in the ordinary rate of epinephrine output or even its total suppression can give rise to symptoms (Stewart). Even the two most constant symptoms thought to be associated with suprarenal insufficiency, namely muscular adynamia and respiratory disturbances, are not produced experimentally by epinephrine loss (Kuehl). Attention is directed, too, to the experiments of Houssay and Lewis, in which complete removal of one suprarenal gland and the suprarenal medulla of the opposite side produced no symptoms in dogs in which no accessory medullary substance was demonstrable at autopsy. Total ablation of both suprarenal glands, however, is invariably fatal; but the symptoms produced are not characteristic, unless it be the extreme muscular weakness which proceeds the exit for some hours. This and other experimental evidence indicates that epinephrine is not necessary for life and directs our attention to the cortex rather than to the medulla as the indispensable portion of the suprarenal gland.

Yet fatal cases are at hand in which simultaneous acute hæmorrhages have destroyed both suprarenal medullæ, leaving the cortex morphologically well preserved. Were it not for the evidence quoted above, one would presume that here the lethal outcome depended upon the destruction of medullary function and structure alone. Or are we to assume that the hæmorrhage and the pressure have so altered the functional capacity of the cortex that although normal in appearance, it, too, is incompetent to perform its function properly? It appears as if there is something more fundamental to be reached in this problem, possibly some involvement of the nervous system.

Cases of sudden death without previous symptoms may possibly be instances in which the organism is suddenly overwhelmed with suprarenal products. On the other hand, those which make a lethal exit only after several days appear to resemble more the picture of experimental complete suprarenal failure, with asthenia as a prominent symptom.

Physical signs are usually of no assistance in locating the seat of the pathology. There may be merely vague tenderness in the lumbar regions or in the epigastrium, or abdominal distention as in our case. There is no pigmentation of the skin as in Addison's disease. Hirsch and Capp (1927) report a case of bilateral thrombosis of the suprarenal veins which was associated with a most marked and unusual cyanosis of paroxysmal nature.

The diagnosis during life is very difficult and has been definitely made in only one of the cases investigated (Foster). That the suprarenal gland was possibly the seat of hæmorrhage was noted antemortem in the case of Ellis and in our own case. The presence of severe abdominal symptoms with few or no physical signs, in a patient who presents definite nervous manifestations, profound asthenia, and gradual decline of blood pressure should lead one to suspect the presence of acute adrenal disease. The leucocyte counts in our case and in those of Kessell and Ellis were high.

The temperature in some of the reported cases has been markedly elevated.

For a time the so-called "white line of Sargent," produced by stroking the skin with the finger, attracted considerable attention as a sign of acute suprarenal insufficiency. Sargent made the diagnosis upon the presence of this line combined with asthenia and hypotension. Investigation by others showed, however, that the white line was not by any means an abnormal reaction and Sargent himself was forced to admit that he was mistaken in its significance.

Materna calls attention to the value of the frog pupillary reaction as an intravitam diagnostic aid of adrenalin auto-intoxication, and gives full directions for a method of procedure. One can by this method, he claims, ascertain with certainty the presence of abnormally large amounts of blood adrenalin. If the test be positive, the clinician is immediately furnished with a clue to the origin of possibly vague symptoms. From a therapeutic standpoint the test if positive would be most valuable in cases of large unilateral suprarenal hæmorrhages, where the correct diagnosis may lead to operative interference and prevent death. It would be interesting to perform this test during life upon suspected cases of acute adrenal disease in the hope of confirming or denying its reliability.

TREATMENT

The treatment of bilateral suprarenal apoplexy has met with little success. Rest and sedatives are, of course, indicated. Injections of adrenalin have been freely advocated. It is not surprising that they are of no avail in the human, when similar injections fail to prolong the lives of suprarenalectomized animals (Kuehl; Banting and Gairns). Injections of adrenalin-free cortex, however, have a definite effect in delaying for hours the onset of symptoms of suprarenal failure in suprarenalectomized animals, and definitely prolong their lives (Kuehl; Banting and Gairns). Experiments on similarly treated animals have contributed the further information that the administration of large amounts of certain fluids have doubled or trebled the life span of these animals over that of the controls (Marine and Baumann; Banting and Gairns; Corey). Investigators well agree that physiological sodium chloride and Ringer's solution act in this manner, whereas there is some disagreement in the efficacy of isotonic glucose and isotonic sodium acetate solutions. The beneficial effect of these substances is probably due to the relief of the dehydration which accompanies suprarenal insufficiency, and the diuresis which they produce. If the water loss is compensated, life is prolonged. With this data at hand, we may look forward with some hope to a more effective therapy. Extracts of suprarenal cortex or the whole gland, and isotonic solutions of sodium chloride or Ringer's solution, are, therefore, our most hopeful weapons.

Surgery offers no help in the treatment of bilateral cases. There are cases of massive unilateral hæmorrhage, however, in which the fatal outcome is due to severe hæmorrhage and shock, rather than to suprarenal failure. Symptoms may localize the condition to one or the other side, and the hæmatoma may be felt in the affected flank. Blood examinations may possibly show an hyperadrenalæmia. Such cases should be given the benefit of surgery with the hope of checking a hæmorrhage, which, if allowed to progress, might terminate fatally. Unless the clinical findings indicate that the condition is unilateral, and unless the side affected can be definitely determined, surgery should not be attempted.

Having decided to intervene, the mode of approach would preferably be through the anterior abdominal wall, through an upper rectus incision, or perhaps through an incision parallel to the costal margin extending into the flank, as is sometimes used for splenectomy. The suprarenals are not easily reached by the posterior route, and cannot be directly attacked unless the kidney on that side is sacrificed. The abdomen should first be explored, palpating both suprarenals. If there is any doubt of the unilaterality of the pathology, all further operative procedure should be suspended. If, however, the unaffected side seems normal one could continue through the posterior peritoneal layer, expose the affected gland, and remove it without injury to the kidney. Any massive hæmorrhage in this region could be controlled.

Extensive bilateral suprarenal apoplexy is uniformly fatal, but suprarenal "strokes" of lighter grade may be survived by the patient. Old hæmorrhage was noted in Brodnitz's specimen. Just how much tissue destruction is necessary to produce acute adrenal insufficiency is unknown. Severe one-sided involvement, with the other side morphologically intact, has been known to produce this syndrome.

We have still much to learn about suprarenal hæmorrhages, their methods of production and the pathological physiology which they produce. Their clinical recognition will give us valuable help; clinical research upon living subjects will clear many points and possibly furnish us with a clue to effective therapy.

SUMMARY AND CONCLUSIONS

1. A remarkable case of bilateral suprarenal apoplexy in an adult is reported. These cases are extremely rare.

2. Thrombosis of the suprarenal veins is the most important etiological factor.

3. Cases have been divided according to clinical manifestations into types; peritoneal, asthenic, and nervous. Asthenia is the most constant and characteristic symptoms. Physical signs are variable.

4. The diagnosis has only once been made before death. The use of blood tests may aid in the diagnosis.

5. The prognosis is hopeless in well marked bilateral cases. Small hæmorrhages may be absorbed without sequelæ.

6. The administration of normal salt or Ringer's solution, and adrenal cortex or whole suprarenal gland are our best therapeutic measures. Epinephrine is without effect.

7. Surgery is useless in well marked bilateral cases. It may be the only hope in unilateral severe hæmorrhages which threaten life by blood loss and shock.

BIBLIOGRAPHY

ARNAUD, CHURTON. Quoted by Lavenson.

BANTING, F. G., and GAIRNS, S. Suprarenal insufficiency. Am. J. Physiol., 1926, lxxvii, 100–113.

BITTORF, A. Zur Kenntnis der Nebennierenerkrankungen. Muenchen. med. Wchnschr., 1928, lxxiii, 1926.

BRASSER, A. Beitrag zur Kenntnis der Nebennierenblutungen. Klin. Wchnschr., 1924, iii, 738.

BRODNITZ. Die Apoplexie der Nebenniere. Muenchen. med. Wchnschr., 1910, lvii, 1591.

CARRINGTON. Quoted by Lavenson.

CHIARI. Quoted by Koch.

CHURTON. Quoted by Lavenson.

COREY, E. L. Effect of forcing fluids upon survival after bilateral epinephrectomy. Proc. Soc. Exper. Biol. & Med., xxiv, 206–207.

Idem. The effect of forcing fluids upon survival after bilateral epinephrectomy. Am. J. Physiol., 1927, lxxix, 633–640.

DUDGEON, L. S. On etiology, pathology, and diagnosis of adrenal hæmorrhage. Am. J. M. Sc., 1904, cxxvii, 134–136.

ELLIS, A. W. M. Hemorrhagic infarction of the adrenals, with the report of a case. Cleveland M. J., 1912, xi, 20–25.

FOSTER, N. B. Report of unusual cases. New York M. J., 1920, cxii, 77.

FRAENKEL, E. Ueber die blutgefaesschaedigende Wirkung des Grippeerregers. Zentralbl. f. allg. Pathologie, Sonderbande, 1923, p. 104.

FREUDEMANN. Ueber Apoplexie der Nebennieren. Deutsche med. Wchnschr., 1920, xlvi, 1275.

GARIPUY and SCHREIBER. Un cas de mort d'un nouveau—ne' par hémorragie surrénale. Bull. Soc. d'obst. de Par., 1908, xi, 23–25.

HEKTOEN, L. Death from hemorrhage into the suprarenal bodies of a boy of eighteen. Tr. Chicago Path. Soc., 1909–10, viii, 87–89.

HIRSCH and CAPPS. Paroxysmal cyanosis associated with bilateral thrombosis of the suprarenal veins. Arch. Int. Med., 1927, xl, 112.

HOUSSAY, B. A., and LEWIS, J. T. The functions of dogs deprived of the adrenal medulla. Compt. rend. Soc. de biol., 1922, lxxxvii, 565–567.

KEMPF, H. Ueber die Bedeutung der Nebennierenblutung fuer den ploezlichen Tod. Vierteljahrschrift fuer gerichtliche Med., 1918, lvi, 71.

KESSELL, J. S. A case of acute hemorrhage into both suprarenal bodies. M. J. Australia, 1925, ii, 456.

KOCH, E. Zur Frage der Herkunft der Massenblutungen ins Nierenlager; Beitrag zur Kenntnis der Nebennierenhaemetome. Deutsche Ztschr. f. Chir., 1912, cxviii, 350–373.

KUEHL, G. Untersuchung zur Hormonwirkung der Nebennierenrinde. Arch. f. d. ges. Physiol., 1927, ccxv, 277–290.

LAEDERICH, L. Bull. et mém. Soc. méd. d. hôp. de Par., 1908, xxv, 37–45.

LAVENSON, R. S. Acute insufficiency of the suprarenals. Arch. Int. Med., 1908, ii, 62.

LISSAUER, M. Zur Kenntnis der Nebennierblutung. Arch. f. path. Anat., Berl., 1908, cxciii, 137–148.

MARINE, D., and BAUMANN, E. J. Duration of life after suprarenalectomy in cats and attempts to prolong it by injections of solutions containing sodium salts, glucose and glycerol. Am. J. Physiol., 1927, lxxxi, 86–100.

MATERNA, L. Auto-adreninintoxikation bei beiderseitiger Nebennierenblutung. Beitr. zur path. Anat. u. s. w., 1910, xlviii, 236.

MICHAUX, J., and MARSSET, H. Un cas d' hémorragie des surrénales. Bull. et mém. Soc. méd. d. hôp. de Par., 1923, xlvii, 161.

MUNSON, J. F. Suprarenal hemorrhage; an unusual case of sudden death. J. Am. M. Ass., 1907, xliv, 19–21.

PAWLOCK. Quoted by Koch.

ROGER. Quoted by Lavenson.

ROUTIER. Quoted by Koch.

SEVERN, A. G. Case of acute bilateral suprarenal hemorrhage. Lancet, 1927, i, 647.

SIMMONDS, M. Ueber Nebennierenblutungen. Arch. f. path. Anat., 170, H 2, S. 242.

STEWART, G. N. Adrenal insufficiency. Endocrinol., 1921, May, p. 283.

VALENTIN. Nebennierenblutung. Deutche med. Wchnschr., 1914, xl, 1725.

VIGOUROUX, A., and COLLET, G. Hémorrhagie bilaterale des capsules surrénales chez un paralytique general; mort sublite. Bull. et. mém. Soc. anat. de Par., 1906, lxxxi, 701–704.

VULPIAN. Note sur quelques reactions propres à la substance des capsules surrenales. Compt. rend. Acad. des. sc., 1856, xliii, 663.

WEIDMAN, F. D. Massive hemorrhage of the adrenal in an adult age 64 years. Proc. Path. Soc. Phila., (1916), 1917, xxxvii, 3.

ZWEMER, R. L. Prolongation of life after complete epinephrectomy. Am. J. Physiol., 1927, lxxix, 658–665.

APPENDICEAL PERITONITIS[1]

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I HAVE been prompted to select appendiceal peritonitis upon which to speak because I believe that vital statistics show entirely too many deaths charged to disease of the appendix. In fact, I believe that there are actually more deaths from acute appendicitis than the statistics show, as many of the cases reported as peritonitis, and intestinal obstruction are due to appendicitis. This may strike you as a bold utterance, nevertheless I think it is true. While deaths caused by acute appendicitis are primarily the result of the disease of the appendix itself, secondarily they are the result of peritonitis and the toxæmia which is caused by peritonitis. Peritonitis plays the most important rôle in the mortality, as experience, bacteriological study, autopsy *in vivo*, and post-mortem examination have taught us.

The pivot around which revolves the logical treatment of acute appendicitis is not so much the appendix as it is the peritonitis. In an illustrative way, the peritonitis has been likened to a conflagration caused by a lighted match. If the match is still burning when the firemen arrive, it does not attract their attention so much as does the conflagration, therefore their efforts are at once directed to prevent extension to surrounding buildings. So in the presence of an appendiceal conflagration, the appendix can be forgotten and attention centered upon the treatment to prevent further extension of the peritonitis.

From its earliest stage, irritation, peritonitis proceeds to its final stage, toxæmia and death. The varieties of peritonitis are the circumscribed, the diffusing, and the diffused. Is it possible that these entities may be individualized and recognized? Yes, according to the organism, the staphylococcus, the colon bacillus, the streptococcus, and other less virulent types. The colon bacillus and the streptococcus are the two most important and most frequent clinical types.

The staphylococcus albus acts as a protector in the true sense of the term, in that its mission is to establish a barrier against the streptococcus and colon bacillus, and thus prevent their breaking through and infecting the peritoneum beyond; in other words, to keep these vicious bacteria within their point of origin, so as to limit the infection to a circumscribed area and if possible to prevent a diffusing peritonitis from becoming a diffused one. In our efforts to combat peritonitis, we must work with nature and not in any way institute an attack that will break down her barriers. It is on this principle that the treatment of anatomical and physiological rest is founded. The two most vicious types of micro-organisms in appendiceal peritonitis, I repeat, are the streptococcus and the colon bacillus. In the more virulent cases the streptococcus is the first to appear. The reason we do not more often find the streptococcus in our examination of smears and cultures made at the time of operation, is that the colon bacillus rapidly overgrows it. Incidentally, I may remark that in every case operated upon in the Lankenau Clinic, a smear and culture are taken of the exudate both at the site of, and distal to, the point of origin of the pathology. The smear is immediately examined in the laboratory and reported on in a few minutes. This I regard as one of the most important parts of our operating room technique. I value the co-operation of the laboratory with the operating room so highly that to break this combination would be a sorrow and tribulation. In abdominal as well as in other operations the findings of the bacteriologist in the examination of the smears taken are our guides as to whether or not to use drainage. In breast tumor cases, I rely on the report on frozen sections for indications whether to remove the organ in addition to wide dissection of the deep fascia or simply to excise the growth. Frozen section diagnosis is made in every tumor case.

In acute appendicitis in the presence of peritonitis, the pith of the question is when to operate, and when not to operate, in order to obtain the best results and the minimum mortality. I believe that in the absence of a forbidding peritonitis, all patients with acute appendicitis should be operated on except in the presence of a grave constitutional condition: a cold, pleurisy, pneumonia, or an eruptive fever, etc. In the absence of contraindications, be the case ever so mild or the patient apparently on the high road to recovery, to advise waiting for an interval or a second attack shows ignorance of the possible effects of delay and is contributory negligence in case of death. I make this statement fully conscious of its meaning. To advise interval operation only because the patient contemplates a long visit away from home is also a dastardly practice. In support of these utterances, I am prepared to say that the occasional operator should not be the one chosen to do the

[1] Read before the State Sectional Meeting of the Clinical Congress of the American College of Surgeons, Wilmington, Delaware, January 17, 1928.

work, but the operator of vast and varied experience in dealing with pathological abdominal riddles should be chosen. Only the latter can best deal with any of the many complications that may be present; with this proviso, I am able to stand back of what I have said. I purposely speak in this manner as I want to give you something to take home with you. In the old days when discussing the subject, we fought like bulls in the arena but behind the scenes we were peaceful lambs. I hope it will also be so today.

I have used the words "forbidding peritonitis." This will be discussed later.

In the presence of a circumscribed peritonitis, removal of the appendix with the proper technique is the correct thing to do. By the proper technique, I mean that the incision should be made lateral to the point or line of greatest tenderness, which indicates the position of the appendix. We should not hesitate to cut the internal oblique and transversalis muscles in a direction opposite to the course of their fibers, if this gives easier and better exposure. To operate with the view of preventing a subsequent hernia is to expose the patient to the greater and more serious risk of dissemination of infection. If the appendix lies close to the cæcum directed upward and outward, an extraperitoneal approach is the safest route and is easily made when, after the overlying muscles have been cut through, the transversalis fascia, which is often œdematous and infiltrated, can readily be separated from the peritoneum and the latter exposed. At this point palpation will often detect fluid. And by hypodermic aspiration the character of the fluid can be definitely determined. The peritoneum is opened in the line of the wound, the fluid, often actual pus or puruloid material, evacuated, and the cæcum and appendix exposed.

If the appendix is not in sight, I at once lift up the overlying abdominal walls with Deaver retractors and thoroughly pack off the surrounding peritoneal cavity with moist gauze pads. If pus is found, it is mopped up during the dissection in freeing the appendix. With a piece of moist gauze, the cæcum is grasped with the fingers and thumb and gently lifted into the wound, which must be large enough to allow carrying the cæcum far enough out of the wound, to expose the anterior longitudinal muscular band, the ileocolic fold of peritoneum, the terminal ileum and the ileocæcal fold of peritoneum which is continuous with the meso-appendix. The base of the appendix is then seen on the outer side of the ileocæcal fold. These peritoneal folds are to the operator what the lighthouses are to the mariner. In the course of the dissection small moist pieces of gauze are so placed as to prevent contamination of the exposed peritoneal spaces. These small pieces of gauze with the previously placed large pieces enable one to guard against contaminating the non-infected, surrounding peritoneum. The appendix being delivered, it is tied off and removed with the cautery knife; a glass drainage tube is carried into the pelvis and aspirated to determine whether there is pus in the pelvis. If the smear of this aspirated fluid shows micro-organisms, the tube is left in; if not, it is removed. A cigarette drain or a rubber tube may later be substituted for the glass tube if drainage is necessary. When the case has been a very dirty one, no attempt is made to close the wound.

In the presence of pus I always examine the external paracolic groove. Occasionally it will also be found to contain pus and if so, I explore farther upward, and often find a collection between the diaphragm and the liver as well as beneath the liver. These respective points are then thoroughly drained. I have operated upon many such cases with excellent results. The latter type of case represents a combined circumscribed and limited diffused peritonitis. In my earlier experience, under the conditions I have just mentioned, I terminated the operation by simply evacuating the collection at the site of the appendix, removing the appendix, and instituting drainage. When practicing this technique I was frequently obliged to operate later for one or more secondary collections, so that I have adopted the technique just described.

If you were to ask me to what I attribute whatever success I have in the surgery of intra-abdominal pus collections, I would answer first, to the location of the collection or collections of pus and second, to the proper disposition of gauze pads, not gauze towels, before I attack the collection. This question was once asked me by that great and master surgeon, the late John B. Murphy; when I gave him this answer Murphy said "Amen." I grant you, this requires skill and art, both of which can be acquired by experience. When, as some of you have heard me, I ask my gauze nurse why she is so confident in telling me that so many pieces of gauze are missing, she answers: "My experience in this job gives me confidence."

A circumscribed peritonitis is easily recognized by the presence of a limited swelling, limited rigidity, limited tenderness, circumscribed pain, and either the absence of peristalsis or hypoperistalsis as compared with the peristalsis surrounding the peritonitic area, together with resonance to light, but dullness and flatness to deep percussion, and limited movement of the abdominal walls over the site of the lesion. In making the diagnosis I

attach the greatest importance to the physical signs. A leucocytic and polynuclear count should be made as a routine measure, but in the majority of instances I attach little importance to either. When I do consider the blood picture, I pay more attention to the polynuclear than to the leucocytic count.

In circumscribed appendiceal peritonitis with the abscess close to the ileocæcal junction beneath the terminal ileum and mesentery, and with the terminal ileum thickened and stiffened, having to a great degree, if not entirely, lost its contractile power, after the pus is evacuated, appendix removed and drainage established, an ileocolostomy or sometimes an ileocæcostomy will make recovery more certain. I have done this many times with most satisfactory results.

This is particularly true in the large abscess cases in which this portion of the bowel forms part of the wall of the abscess cavity, for then not only the patient's recovery is better assured, but also his immediate postoperative comfort, for there is less likely to be pain from the retention of gas. Again, secondary operation for obstruction that occurs occasionally in these cases three or four or more days after operation, is avoided.

Let us now consider diffusing peritonitis, by which is meant a spreading inflammation not involving an extensive area and differing from the circumscribed variety in that it is not limited. In the diffusing peritonitis, there is both peritoneal inflammation and peritoneal irritation, the latter being the forerunner of the former. You may regard this as a distinction without a difference but I hope to show you that it is not. Diffusing peritonitis differs from the circumscribed variety in that, while the patient looks and is sicker, yet he has not the peritoneal facies. The pain is more pronounced and is referred over a greater surface; there is a much larger area of rigidity and tenderness, peristaltic sounds are either absent or very feeble, or peristalsis is aggravated around the inflamed area corresponding to the area of peritoneal irritation, and abdominal breathing is more limited than in circumscribed peritonitis. Diffusing peritonitis is definitely recognizable by the careful observation of these physical signs. Time and again have I demonstrated this to my classes and subsequently proved it at operation by the presence of inflammatory adhesions, adherent coils of bowel and adherent omentum occupying the area mapped out as the site of the inflammation when examining the case before the peritonitis had subsided. Cases of diffusing or spreading appendiceal peritonitis are not operated upon until the subsidence in part or in whole of the peritoneal inflammation, which in the experience of the Lankenau Clinic practically always takes place if strict anatomical and physiological rest, "regulation" as we call it, is carried out. I regret to say that outside of our clinic when I see this treatment it is not always given correctly. The familiar saying, "what is worth doing at all is worth doing well," certainly applies here; therefore, even at the risk of trying the patience of those of you who are as familiar with it as I am, I shall describe this treatment in detail.

First allow me to say, as you know, this is better known as the Fowler-Murphy-Ochsner treatment (a galaxy of stars, of master surgeons, whose memory and great achievements have been left to us as a priceless heritage). In the Lankenau Clinic, for brevity of expression, we style it regulation, but not in any sense in the attempt not to use the names of the originators, for they are names to conjure with.

Anatomical and physiological rest means rest of the body and of the alimentary canal. Rest of the body consists in confining the patient to bed in a sitting position, which is maintained by means of a pillow placed beneath the tuberischii and a folded sheet carried beneath the portion of the pillow anterior to the tuberischii, the ends of the sheet being carried to the head of the bed to which they are tied, the patient's back being supported by pillows, and a pillow placed beneath the knees.

To keep the patient in this position calls for much attention upon the part of the nurses. The position can be made easy to a great extent by the mechanical beds used in many hospitals, but they are not used in our clinic. Rest of the body is further aided by giving small doses of morphia, which serves a double purpose in that it also rests the small intestine by reducing peristalsis. Rest of the alimentary canal, physiological rest, is obtained by washing out the stomach, giving nothing by mouth, either in the way of water or nourishment, by giving enough morphia hypodermically to prevent active peristalsis, applying ice to the abdomen to benumb the nerves of the walls of the abdomen, this in turn affecting the abdominal sympathetic nerves with which the nerves of the abdominal walls communicate through the spinal ganglia, and lastly giving the Murphy drip of normal saline solution to which is added glucose and whisky. It is not uncommon to be told by nurses that the patient will not take the intrarectal solution, but this happens only when it is not being properly given. This was stressed by Murphy when he first described the method, stating that the height of the container of the solution above the level of the mattress, must be

such that the intra-abdominal pressure and the pressure of the solution entering the rectum are equally balanced. For example, if the pressure of the saline solution is too great, as happens when the container is placed too high, the solution will not be retained, while if the reverse is the case, no fluid enters the bowel. This calls for intelligence and knowledge on the part of the attendants. This treatment must be consistently carried out until the conflagration, the peritonitis, is under control, as evidenced by restoration of normal peristalsis which has been held in abeyance to prevent dissemination of infection, and which can be recognized by abdominal auscultation and the passing of flatus, a sound so harmonious to the ear of the doctor and the nurse. This indicates that the crest of the wave has been reached and the storm will soon abate. It further means that the peritonitis will either entirely clear up or become circumscribed, when operation can be done with a greater degree of safety than when the storm is raging. Richardson expressed the idea so well when he said "too late for an early, and too early for a late operation."

The rationale of this treatment is worth while detailing. Washing out the stomach quiets the movements of the diaphragm, the under surface of which is so rich in lymphatics and lymph spaces, and this quiescence affords the patient immediate relief. The diaphragm, when in active motion, performs the function of a suction pump in that infection is rapidly drawn into the lymph spaces and the lymphatics through which it is carried into the blood stream, causing blood stream infection. This is sufficient reason not to give medicines or anything by mouth, that might excite nausea or vomiting. In the presence of the latter, lavage should be repeated. It is a well known physiological fact that water given by mouth is absorbed by the terminal ileum and the first portion of the ascending colon and to reach the latter it must be carried by peristalsis of the small bowel, which in turn means danger of spreading the infection. This means we drink with our terminal ileum and the first portion of the colon. On the other hand, if the intestines are parietic, the plexuses of Meissner and Auerbach under the control of toxins, fluid given by mouth will cause waterlogging, overdistention and reverse peristalsis, regurgitation of duodenal and stomach contents and vomiting, a further indication for lavage or the passage and retention of a duodenal bucket in the stomach to maintain continuous drainage.

The second physiological fact is that absorption of nourishment takes place in the small intestine; therefore we eat with our small intestines. Sir Berkeley Moynihan's lines

> Perforation spells purgation in an appendix kinked and bad. Foods and drink worry him, and aperients turn him mad,

exemplifies the rationale of arresting peristalsis by not giving anything by mouth. I am sure many, or some of us, at any rate, recall reading that wonderful little book, long since out of print, by the distinguished Englishman, Hilton, on rest and pain, which supports the rationale of putting the intestines at rest and abolishing pain by giving morphia. However I do not think it necessary to go so far as did Alonzo Clark or does our distinguished colleague and friend Crile, who gives enough morphia to reduce the respirations materially. As I see it, the therapeutic indication is carried out when we abolish peristalsis and pain and maintain rest of the body. The fact that nature does this in the late stage of peritonitis, toxæmic abeyance of peristalsis suggests the rationale of physiological rest.

This I believe is sufficient to impress upon you why I advocate the treatment of anatomical and physiological rest or "regulation," as we prefer to call it. It is not at all uncommon, when I am called at night by 'phone, to be told that a case of appendiceal peritonitis, sick for 3 or 4 days, has been admitted to my hospital service, for Mrs. Deaver to say: "Tell them to put him on 'regulation.'" This may suggest how familiar this treatment is in some home circles. I do not hesitate to say that any form of treatment other than this is unanatomical, unphysiological and entirely out of tune with nature's forces, therefore not only irrational, but illogical. I am prepared to say that this treatment cannot be thoroughly carried out in the home, but only at the hospital, and often here it is not successful, for want of absolute faith begotten by large experience with it, and the want of knowledge how to use it. Faith here, as in religion, we must have to award our peritonitis patients and to award ourselves. Before leaving this subject, I might say that, in addition to this treatment, hypodermoclysis and intravenous saline with glucose are used in the very dehydrated cases. I have not had much success with continuous intrasaline as practiced by Matas, partly due, no doubt, to the extreme condition of the patient when the treatment was instituted. Does this not often happen with extreme measures used when too late to expect good results?

Finally, let us discuss diffused appendiceal peritonitis. Diffused appendiceal peritonitis, in its early stage, presents a picture familiar to us all, with its general rigidity of the anterior abdominal

wall, tenderness corresponding to the area of rigidity, practical absence of abdominal breathing, the peritoneal facies, rapid pulse, tense and often bounding, comparatively high temperature, and exaggerated peristalsis. The blood picture shows eighteen to twenty thousand leucocytes, and eighty-five to ninety-five polynuclears, the latter varying with the type of the infection. Twenty to forty hours after onset of the peritoneal inflammation, or earlier if the patient has been purged, the picture changes to one of general abdominal distention, the rigidity being much less pronounced, tenderness not nearly so decided, entire absence of peristalsis, later followed by tinkling and finally a silent belly, an ominous sign when only the pulsation of the abdominal aorta is heard louder than normal and a rapid pulse with diminished volume, more pronounced peritoneal facies, a blood picture of moderate or low leucocytosis but high polynuclear count, diminished output of urine that shows albumin, hyaline and granular casts, relaxed skin that later is sweaty and cyanotic, vomiting or regurgitation of dark vomitus, often foul smelling, and restlessness and an active brain. This presents what is considered a hopeless proposition, but not necessarily so if the treatment already described is carried out early and to the letter. I have seen recovery with local abscess formation, the simple evacuation of which was followed by convalescence. When much of the active peritoneal inflammation has subsided but has left multiple foci of pus, the patient dies of toxæmia. When the peritoneal inflammation has only partially subsided and has left a large collection, involving the pelvis and the lower abdomen, the patient may sometimes, by drainage alone, get well. These are cases in which puncture through the rectum or the vaginal vault have occasionally proved successful.

I have, however, seen instances of the latter type in which death occurred a few hours after a simple puncture. In this class of cases shortly following the puncture, there is a sudden marked rise of temperature, always a precursor of death.

THE CLINICAL SIGNIFICANCE OF CHOKED DISCS PRODUCED BY ABSCESS OF THE BRAIN[1]

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THE ocular syndromes produced by brain abscess and brain tumors are similar, but in the former the ophthalmoscopic evidence that the associated choking of discs has reached a definite stationary height or is still developing is of great importance from a neurosurgical standpoint.

The formation of a brain abscess was well described by Macewen in 1893 and since that time little has been added to his classic work. He divides the clinical sequence of events produced by the formation of a brain abscess into the initiatory stage, characterized by severe head pains, vomiting, rigor and fever; the second stage, characterized by deadening of the head pain, which can be elicited only on percussion, slow cerebration, want of sustained attention, apyrexia, slow pulse, paralysis, and optic neuritis; and the terminal stage in which there is either leakage of the pus into the membranes or ventricles accompanied by fever, convulsions, and coma or complete encapsulation of the abscess which may remain quiescent for a long period and finally may become absorbed, in some cases without surgical interference.

In Macewen's cases "optic neuritis" was frequently seen, especially in the later stages, and was usually mild although in some cases the swelling of the optic discs advanced rapidly and even increased after the abscess had been evacuated. The term "optic neuritis," which was used up to 1893 and even later in describing the œdema of the optic discs produced by brain abscess or tumor has been replaced by the term "choked discs," inasmuch as the œdema is due to increased intracranial pressure and is not the result of inflammation. In cases of choked discs there is no loss in visual acuity or changes in the perimetric fields characteristic of optic neuritis.

The cases observed in the Mayo Clinic in which brain abscess has been associated with choked discs were in the second and third stages (Macewen). In the other cases of brain abscess there has been a fulminating course with early death without the appearance of choked discs. Clinically the ocular syndromes produced by encapsu-

[1]Read before the Clinical Congress of the American College of Surgeons, Detroit, October 3 to 7, 1927.

lated brain abscess are the same as those produced by tumor of the brain. In 11 cases of definitely encapsulated abscess of the frontal lobe, the bilateral choked discs in 8 ranged from 1 to 6 diopters. The visual acuity was good in all cases and the perimetric fields revealed only mild concentric contraction for form and color. Only one abscess of the frontal lobe which produced a typical basal frontal syndrome could be located ophthalmologically. This does not agree with Eagleton's experience in cases of abscess of the frontal lobe. In cases of temporal and temporosphenoidal abscess there was the typical ophthalmological syndrome produced by tumor in that region: normal visual acuity, bilateral choked discs, and homonymous hemianopic defects of the visual field. This same syndrome was revealed in cases of abscess of the occipital lobe. The choked discs also varied from 1 to 6 diopters in these groups. In cases of abscess of the cerebellar lobe, a choked disc of more than 2 diopters was not observed, which is quite the opposite to observations made in cases of cerebellar tumor. In all of the groups the pupillary disturbances, oculomotor paralyses, and nystagmus were of no clinical importance in determining the site of the abscess.

Repeated ophthalmoscopic observations of the choked discs is of great importance in cases in which the diagnosis of brain abscess is definitely established, as the ophthalmologist can be of aid in determining more or less accurately the time at which the abscess is completely encapsulated. In the Mayo Clinic it has been noted that the best results are obtained by operation in those cases in which the neurological and ophthalmological syndromes could not be distinguished from those produced by a brain tumor similarly situated. In such cases the history and the pathological changes in adjacent structures established the diagnosis of abscess. In every case there was choking of the discs which had reached its maximal height and was stationary. The encapsulated abscess then acted purely as a foreign body or tumor to which the cerebral tissues had become adjusted. When operation was performed during the period when choking of the discs was increasing the postoperative course was stormy and the mortality rate rather high. As a rule the choking of the discs reaches the maximal height in a relatively short time, so that surgical interference is not delayed and the ultimate prognosis is much better. Choked discs are not present in all cases of encapsulated abscess, just as they are not found in all cases of brain tumor and their absence should not be misleading. The presence of choked discs, especially in association with mastoiditis, and questionable intradural involvement, does not prove the existence of brain abscess and hasty intracranial operation is to be discouraged in those cases.

CONCLUSIONS

1. The ocular syndromes produced by an encapsulated brain abscess are the same as those produced by a brain tumor similarly situated.
2. Choked discs in cases of cerebellar abscess have less elevation than those produced by cerebellar tumors.
3. The presence of choked discs in cases of intradural suppuration does not always signify the presence of brain abscess.
4. Rapidly developing choked discs in cases of brain abscess are significant of a changing cerebral process, intracranial operations during this period give unsatisfactory results.
5. Stationary choked discs in cases of brain abscess observed over a short period of time indicate encapsulation. Intracranial operations during this period give excellent results.
6. Repeated ophthalmoscopic examination of choked discs in cases of brain abscess is of great prognostic value.

BIBLIOGRAPHY

1. Eagleton, W. P. Brain abscess, its surgical pathology and operative technique. New York: The Macmillan Company, 1922, p. 208.
2. Lillie, H. I. and Lillie, W. I. Choked discs in association with surgical mastoid disease without apparent intradural involvement. Arch. Otolaryngol., 1925, ii, 355–361.
3. Lillie, W. I. Ocular phenomena produced by basal frontal lobe lesions. Tr. Sect. Ophth. Am. M. Ass., 1927, 167–192.
4. Macewen, William. Pyogenic infective diseases of the brain and spinal cord. New York: The Macmillan Company, 1893, 130–145.

THE HORSLEY PYLOROPLASTY IN ACUTE PERFORATED DUODENAL ULCERS[1]

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AFTER Horsley (2) published the technique of his pyloroplasty in 1919 considerable interest was revived in this type of operation. Erdmann and Carter (1) published a series of 56 cases in 1925, in which the Horsley technique was followed. The results shown in this series were very satisfactory and in reviewing 56 histories and follow-ups, the authors reported a symptomatic ulcer cure in 94 per cent. Of their series they were able to trace 84 per cent of all cases. My experience with the Horsley pyloroplasty in chronic ulcers has been limited to 3 cases. One had a recurrence within 10 weeks following operation, one died from a pulmonary embolus while in the hospital, and the third case has had a gastric disturbance but not a typical recurrence and the roentgenological examination of the gastro-intestinal tract was negative.

In acute perforated duodenal ulcers it appeared that this type of operation would be ideal, as the ulcer could be excised and the stomach left practically in its normal anatomical and physiological state. For that reason between 1923 and 1926 inclusive, the Horsley pyloroplasty has been done in 12 cases of acute perforated duodenal ulcers. The result of this series seems to be of some interest. Two cases were operated on in 1923, four cases in 1924, three cases in 1925, and three in 1926. All were males, the youngest being 25 and the oldest 48, the average age being 35 years. The shortest time between the perforation and operation was 4 hours, and the longest time was 15 hours.

Location of lesion. In each case the ulcer was found on the anterior superior surface of the first portion of the duodenum. The perforation varied from 2 to 8 millimeters. The duodenum was easily mobilized, and excision was possible without difficulty.

Technique of operation. The technique as described by Horsley was followed, and the incision was usually 1 inch on the duodenum and from 1.5 to 2 inches on the stomach. The mucosa was always sutured with No. 1 chromic gut. I am aware that Horsley later gave up suturing the mucosa as he felt that it was a factor in causing recurrences. Then a Cushing right angled suture of No. 1 chromic was used, followed by a Lembert running suture of No. 1 chromic. The abdomen in all cases was closed without drainage. The excised tissue was submitted for histological study, and each ulcer was shown to have been completely excised.

Follow-up. One case died from pneumonia on the third day after operation, this case being the one which perforated only 4 hours previous to operation. Two cases have not been followed, although they were personally instructed about the importance of returning to the Follow-Up Clinic. The fourth case has been symptom free for 3½ years, and the fifth case has been symptom free for 3 years, but returned 14 months ago with acute appendicitis. This patient was operated upon by me, and the duodenum was inspected at the time of the appendectomy and was found normal. The pylorus admitted the tip of the index finger and there were no adhesions about it. A sixth case operated upon 4 years ago had a definite recurrence, both clinically and roentgenologically, 3 months following the operation. The seventh case, operated upon 23 months ago was perfectly well for 15 months, when he began having fullness in his stomach which was followed by a nausea and vomiting. Roentgenological examination revealed two-thirds of the barium meal retained after 6 hours. He was operated upon 7 months ago, and the pylorus was found obstructed but no masses could be detected. A posterior gastro-enterostomy was done. Since the second operation the patient has been free from symptoms.

This leaves five cases which have been bothered with abdominal discomfort after eating, the discomfort being similar to ulcer pain but lasting only a few days at a time. Of these cases one was operated upon 16 months ago, another 28 months, the third 33 months, the fourth 42 months, and the fifth 45 months. The pain in all these cases had some degree of periodicity, returning at intervals of 2 to 5 months. A roentgenological examination of the gastro-intestinal tract in all five patients was negative. Each patient has had two or more examinations. The patients were given dietary instructions to follow on leaving the hospital. None of these cases had any evidence of cholecystitis or cholelithiasis at the time of the operation. Gastric analysis showed a variation in their total acidity of from 40 to 70 per cent, the average being 53 per cent. Erdmann states that in perforations it has been his custom for years to do

[1] Read before the American Gastro-Enterological Association, Washington, May 1, 1928.

an excision. This he did before Horsley's article was published, practically as Horsley's operation for non-perforated ulcers was described, but added to his plastic a gastrojejunostomy. However, having had occasion to reoperate upon one of these patients, and having found a much wider duodenum than normal at the site of excision and plastic operation, he decided to refrain from doing the added gastrojejunostomy. He fails, however, to state how many perforated ulcers he has operated upon since giving up the added gastro-enterostomy.

SUMMARY AND CONCLUSIONS

1. In this series of 12 cases there was one death, and two cases cannot be traced.
2. Two patients are entirely well to date, one for a period of 3 years, and the other for 3½ years.
3. One patient had a definite recurrence and another a pyloric stenosis which necessitated a gastro-enterostomy.
4. Five cases were not symptom free and could not be classed as having satisfactory surgical results.
5. This leaves 9 cases which have been followed, or a total of 22 per cent that are entirely well following this type of operation.
6. In view of the above results, one does not seem justified in continuing to use this type of operation.

I am indebted to Dr. Carl G. Burdick, Director of the Fourth Surgical Division of Bellevue Hospital for the privilege of reporting these cases.

BIBLIOGRAPHY

1. Erdmann, John F., and Carter, Rupert F. The operative treatment of duodenal ulcer with special reference to the Horsley operation. Ann. Surg., 1925, March.
2. Horsley, J. Shelton. A new operation for duodenal and gastric ulcer. J. Am. M. Ass., 1919, lxxiii, No. 8.

RESTORATION OF THE FEMALE URETHRA AND VESICAL SPHINCTER

An Operative Technique Resulting in Urinary Control[1]

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Complete loss of the urethra is a comparatively rare condition and its replacement with the creation of a functionating vesical sphincter is a matter of considerable difficulty. The employment of patience and care may, however, overcome the most serious obstacles. We wish to report a technique leading to a highly satisfactory functional result.

Ward well states that no two cases are exactly alike and the technique must be improvised to cope with the particular conditions of the individual case. Many methods have been suggested and tried but very few results have actually been effective.

Baker Brown (1863) perforated the anterior vaginal wall obliquely with a trocar below the clitoris and made a puncture wound into the bladder. Through this opening he introduced a silver catheter, and eventually, after the wound healed, obtained a urethra which gave complete continence of urine, provided the bladder was emptied frequently.

Kelly elaborated this idea of the tunnel in the mucosa in the anterior vaginal wall. He dissected an elongated tongue of mucosa from behind the fistula and pulling it forward over the fistulous opening and into the tunnel, made a new urinary canal, the anterior half of which was epithelialized. Noble, Sellheim, Péan, and others successfully reconstructed the urethra, transplanting flaps from various parts of the labia, vaginal wall, etc., but the restoration of urinary continence following these procedures has not been frequent. Richards and Rosser employed free transplants of fallopian tube and of the vermiform appendix and secured functionating urethras.

The construction of an artificial sphincter is a difficult problem. Deming transplanted a strip of gracilis muscle and brought the urethra through a loop made like a raquet in the end of the transplanted muscle which supplied the urinary canal with a support which had sufficient tonus to allow the bladder to excrete normally.

Ruebsam and Brjosowsky employed the pyramidalis and levator ani muscles and obtained satisfactory functional results. The suture of a torn sphincter is not a difficult procedure and is frequently reported, but the difficulty lies in cases in which, through trauma or slough, it has been entirely destroyed.

[1] Read before The Clinical and Pathological Section of the Cleveland Academy of Medicine.

Fig. 1.

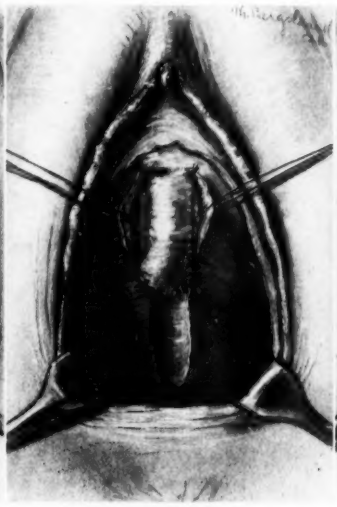

Fig. 2.

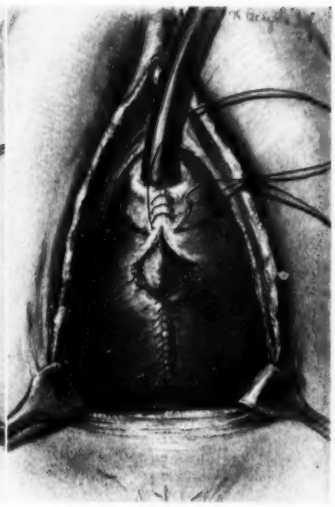

Fig. 3.

Fig. 1. The fistulous opening in the anterior vaginal wall. Outline of the denudation.

Fig. 2. Mobilized strip of mucosa turned anteriorly and sutured to anterior flap covering fistula and producing a completely epithelialized tube.

Fig. 3. Suture of the vaginal flap over the new urethral canal, with a retention catheter in the urethra, and closure of the defects beside the fistula (the weak point). The mucosa was rolled in throughout the whole length of the incision.

In the case here reported we attempted to construct a mucosa-lined urethra and then at the second stage to improvise a sphincter by employing transplanted strips of levator ani muscle as pedicle grafts encircling the urethra at the neck of the bladder. In view of the difficulty of obtaining a successful functional result in many cases of incontinence it seems worth while to give the history of the case and operative technique in detail.

Mrs. R.; colored; aged 30 years; v-para. Patient came into The Lakeside Hospital complaining of frequency of urination since her last pregnancy 5 years ago, with almost complete incontinence during the last several months. Her last labor was somewhat difficult and she had had intermittent incontinence of urine since that time, although total loss of control had developed only within the last year. There had been also a gradual increase in the amount and duration of the menstrual periods. The baby had been large, but there had been no instrumental delivery or operative procedure attempted. The Wassermann was negative.

On examination we found the outlet to be relaxed. There was a moderate cystocele and rectocele. The urethra had been torn away and the situation of the present urethral orifice was almost exactly at the neck of the bladder. The opening admitted a little finger which could be passed through the neck of the bladder. There was a polypoid ectropion of vesical mucosa in the form of a papillary growth which acted almost as a ball valve. The cervix was in good condition. The uterus was anterior, enlarged to three or four times its normal size by multiple myomata, one of which on the anterior surface encroached upon the bladder. The uterus was freely movable, and there were no lateral masses.

It was decided merely to attempt the reconstruction of the urethra and bladder sphincter, and perform hysterectomy and perineorrhaphy later. There was considerable scar tissue in the vaginal vault which made the denudation somewhat difficult.

Operation. The redundant vesical mucosa was carefully excised and the vesical neck narrowed by fine catgut sutures placed deeply enough to involve the muscle of the bladder neck in the area where the mucosal attachment was excised. An incision was then made in the vaginal mucosa at a point approximately 1 centimeter from the midline, extending from the fistula to the proposed external orifice of the urethra. A similar incision was made on the other side. This flap was undermined for about one-third of its width bilaterally, leaving a rather wide point of attachment through its entire length, in order to insure its blood supply (Fig. 1). A spade-shaped incision was made posterior to the fistulous opening and the flap was turned through 180 degrees to cover the fistula and to form the anterior wall of the new urethra. The transplanted flap of mucous membrane was joined to the strip left on the vaginal wall with a running stitch of fine chromic catgut, this forming a completely epithelialized tube and replacing the urethral orifice at its proper position (Fig. 2).

A small mushroom catheter was placed in the bladder. The lateral flaps of the anterior vaginal

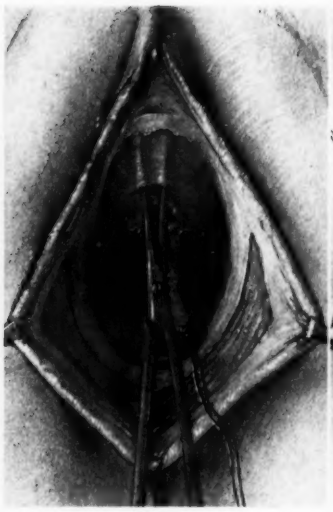

Fig. 4.

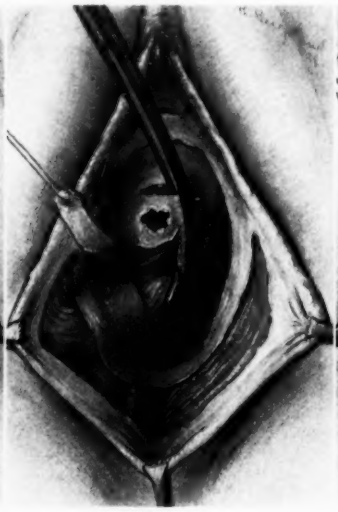

Fig. 5.

Fig. 6.

Fig. 4. A flap is mobilized as before behind the opening of the urethra, and a tunnel dissected to a point *higher* than the normal urethral orifice.

Fig. 5. Perforation made across roof of vagina to grasp opposite levator edge which has been exposed and cut off.

Fig. 6. Suture of the levator muscle transplants around the end (i.e. at the present orifice) of the urethra, for the purpose of forming a circle of muscle preliminary to the lengthening of the urethra.

wall were well mobilized by undercutting further and were finally brought together over the new urethra with as much of the vesical fascia as it was possible to approximate in the midline (Fig. 3).

The catheter was left in place for 11 days, and the patient was discharged on the fourteenth postoperative day. It was necessary for her to void about every 20 minutes or leakage from the urethral orifice would occur. We did not hope for a complete take of this epithelial tube. The operation, however, gained us at least one-half inch of urethral canal.

On January 10, 2 weeks later, the patient was re-admitted to the hospital, very ill, with a temperature of 40.4 degrees C., complaining of marked pain in the right kidney region. Examination revealed a right-sided colon bacillus pyelitis, and the urine was loaded with pus.

In an effort to limit her frequency of urination, the patient had greatly reduced her fluid intake. She was put on large doses of potassium citrate and fluids were forced. On this treatment the urine was clear in 3 days except for a trace of albumin. Urine culture was negative after 5 days. The blood urea and phenolsulphonphthalein output were within normal limits. After the temperature had been normal for 7 days, an attempt was again made to improve the functional condition of the urinary apparatus. The patient had complete bladder control when sitting and almost complete control when on her feet, if the bladder was emptied frequently. If the bladder became at all distended there was an annoying leakage, and she had nocturnal incontinence. The problem then seemed to be a matter of the restoration of the vesical neck and re-establishment of an adequate sphincter.

On examination we found that the distal end of the urethra, measuring approximately 2 centimeters had sloughed. There was about one-half inch of urethra remaining. The cervix showed no gross lesion and the uterus was anterior, freely movable, and enlarged by multiple fibroids. First a supracervical hysterectomy was performed.

Operation. The operation for extension of the urethra with construction of the vesical sphincter was carried out as follows: A flap of mucosa one-half inch wide was dissected free from the anterior vaginal wall up to the inferior opening of the urethra where a rather broad attachment was left (Fig. 4). A transverse incision one-half inch long was made through the vaginal mucosa just anterior to the upper margin of the present urethral orifice and a similar incision was made below the clitoris in the midline by means of scissor dissection, and the mucosa was elevated, forming a small tunnel for the new urethra (Fig. 4).

The employment of strips of transplanted levator ani muscles and fascia as reinforcement for the sphincter was attempted next. A Hegar denudation of the posterior vaginal floor was made and the strips, approximately 1 centimeter in diameter, were cut from the medial edges of levator ani muscles. The pedicles of the strips were situated almost at the level of the bladder sphincter in the lateral vaginal wall. With blunt dissection tunnels

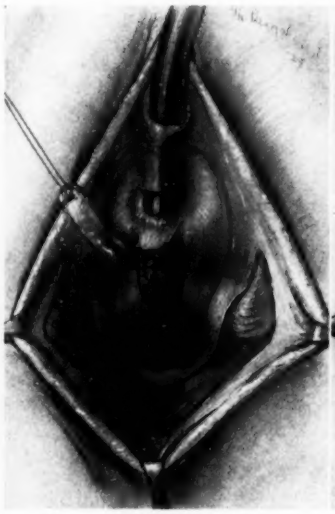

Fig. 7.

Fig. 8.

Fig. 9.

Fig. 7. Insertion of retention catheter through the new sphincter.

Fig. 8. The mobilized flap of mucosa is pulled forward through the canal in the submucosa covering the opening of the present urethra and forming an epithelial covering for the anterior wall of the new urethra.

Fig. 9. Suture of the submucosal fascia and vaginal mucosa is complete and the closure of the mucosa of the posterior vaginal wall is being completed in a T shape to avoid tension.

were made under the lateral vaginal mucosa on either side of the urethra to accommodate the muscle transplants. The two strips of muscle were pulled up to the bladder neck, (Fig. 5) and were crossed and sutured anterior to the urethra and the ends approximated posterior, thus forming a complete ring of muscle (Fig. 6). A small mushroom catheter was inserted at this point through the tunnel in the anterior vaginal mucosa and between the two strips of levator ani muscle (Fig. 7). The flap of vaginal mucosa which had been dissected free from the cervix (Fig. 4) was brought through the tunnel along the anterior surface of the catheter to form the anterior outer surface of the new urethra (Fig. 8). Two interrupted chromic No. 00 sutures were taken in the angle of the pedicle near the neck of the bladder on each side to repair the two small lateral defects where the mucosal flap was bent sharply upon itself as it entered the tunnel. The denuded portion was closed with a continuous chromic catgut suture, the superficial fascia being closed first with mattress sutures (Fig. 9). Near the sphincter of the bladder the vaginal mucosa was dissected rather far back to allow its better mobilization. This was everted somewhat by deeply placed sutures, thus creating a bulkhead over the neck of the bladder to reinforce the small lateral defects at the edges of the new urethra. The perineorrhaphy was completed, and the raw edges of the levator ani muscles approximated with interrupted chromic catgut sutures. The superficial fascia and the mucosa were closed with continuous sutures.

The transplanted levator ani muscles could now be felt lying in the upper lateral walls of the vagina. The vagina barely admitted two fingers, and was the source of some anxiety to us because we feared dyspareunia might result. The point of greatest narrowing was at the neck of the bladder about 1.5 inches from the outlet. The urinary stream now was diverted into a canal the posterior wall of which consisted of the united levator muscle transplants and suture line (Fig. 5). We failed to examine the subsequent degree of epithelialization of the urethra because dilatation of the newly formed sphincter by urethroscopy seemed unwise.

Immediate convalescence was uncomplicated. The catheter was removed on the twelfth postoperative day and the patient was completely incontinent. She had a chill the following day, with headache, malaise and leucocytosis. The urine showed a few pus cells. The temperature returned to normal in 3 or 4 days. Careful investigation of the urine, pelvis, and lungs failed to reveal the source of the chill. The catheter was re-inserted without discomfort and there was no leakage.

The catheter was removed on February 26, 15 days later, and the patient had fair voluntary control of urination. Occasionally the urine escaped without her knowledge, but by emptying the bladder fairly frequently she was able to maintain a fair degree of continence at the time of her discharge from the hospital.

We have made periodical examination of the patient since the operative procedure. The last examination, 10 months after the operation, revealed the urethra measuring approximately 1 inch in length from the vesical neck to the orifice. At least one-half inch of urethra was lost by slough following the second operation. The vaginal orifice at its narrowest point admits two fingers freely, and the patient says that she is perfectly comfortable and has practically as good control of urination as at any time in her life.

It is probable that in the light of the outcome of this case, we will employ only the procedure shown in Figures 4, 5, 6, 7, and 8 in future cases in which restoration of the urethra and sphincter is indicated.

At examination approximately a year after operation we found the patient fully continent regardless of the amount of the fluid intake except for the very occasional loss of a few drops. She has no nocturia and the use of a pad is never necessary. It is noteworthy that firm pressure exerted on the midpoint of the vaginal floor at the outlet pulls on the levator muscle transplants and urine flows from the urethral orifice which promptly stops when the pressure is removed and the urethral orifice again becomes slit-like as the sphincteric action again comes into play.

The omission of the perineorrhaphy might have been an advantage as a scrutiny of the mechanics of revamped levator muscle attachments shows. As has been stated above, any pull on the perineal floor also pulls down on the urethral floor, which favors leakage.

It appears from the examination of urinary function in this case that this result is not merely dependant on narrowing the urethra at some point by the interpolation of an artificial bulkhead; the patient is able to void as well as to stop urination at will and to produce visible voluntary contraction of the sphincter.

We believe that we are justified in recommending further trials with levator muscle transplants in the repair of vesical sphincter defects in the female.

REFERENCES

Brjosowsky, A. Ein neues Verfahren der Sphincter plastik bei der Harn-inkontinenz. Arch. f. klin. Chir., 1923, cxxiii, 117.

Brown, B. Three cases of artificial urethra. Brit. M. J., 1863, ii, 390.

Deming, C. Transplantation of the gracilis muscle in the treatment of incontinence of urine. J. Am. M. Ass., 1926, lxxxvi, 823.

Noble, C. The new formation of the female urethra, with report of a case. Am. J. Obst., 1901, xliii, 170.

Noble, C., and Kelly, H. Gynecology and Abdominal Surgery. Philadelphia and London: W. B. Saunders Co. 1908, i, 501.

Ward, George G. Operative treatment of inaccessible vesicovaginal fistulæ. Surg., Gynec. & Obst., 1917, xxv, 126.

Idem. Reconstruction of the urethra after complete loss, complicating extensive vesicovaginal fistulæ. Surg., Gynec. & Obst., 1923, xxxvii, 678.

A CONSIDERATION OF BLADDER TUMORS WITH SPECIAL REGARD TO THE THERAPEUTIC MEASURES BEST SUITED TO THE DIFFERENT TYPES[1]

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BEFORE the introduction of fulguration and radium therapy, the only means at our command for the treatment of bladder tumor was surgery. The necessity of differentiating one type of bladder tumor from another was a matter of trivial importance.

The first effort of the surgeon for the cure or destruction of the bladder tumor entailed suprapubic exposure and cauterization by means of the hot iron or by the more modern forms of cautery. If the tumor was pedunculated or even sessile, but non-infiltrating, the immediate results were entirely satisfactory in that the growth could be completely eradicated. As these cases were followed subsequently, however, it was soon found that bladder tumor had an extraordinary tendency to recur. In many instances in which the operator had succeeded in removing a simple single growth, multiple tumors were found some months later. A second operation with destruction of the recurrent tumors would again be followed by recurrence. While cures were occasionally obtained and freedom from recurrence was ultimately secured, this happy result was exceptional, most of the patients eventually dying of extensive carcinoma of the bladder. The results were so discouraging that many urological surgeons advised operating only in cases of necessity for the relief of some complication. The failure of the surgical procedure in this type of tumor is due, not so much to the procedure itself, but to the lack of means of treating recurrence. Tumors of this type can be thoroughly and effectively destroyed by cauterization but the growth of new tumors cannot be prevented.

Formerly, when the tumors were infiltrating, especially deeply infiltrating, very few if any satisfactory results could be secured by any methods of cauterization then available. The rapid realization of the ineffectiveness of these methods for the cure of infiltrating tumor led the bolder surgeons to attempt resection. The results obtained by the radical resection of the tumor area with a margin of healthy bladder wall gave surprisingly excellent results and many surgeons were led to adopt this method absolutely in tumors of the non-infiltrating type. The results, however, in this latter group were not as satisfactory, so far as ultimate cure was concerned, because of the greater tendency to recurrence. The suprapubic exposure of these non-infiltrating types of tumors resulted not infrequently in tumor implantations at points in the bladder previously uninvolved as well as in the suprapubic tract.

With the introduction of fulguration by Beer in 1910, there began a new era in the treatment of the more benign papillomatous tumors. More recently, the introduction of radium has proved of great value in the more malignant forms of tumor.

The object of this paper is to show the necessity of careful differentiation of the various types of tumor and to point out forms of treatment which experience has shown will give the best results. For example, in one group, fulguration will be successful; in another group, resection is the method of choice; in another, radium applied to the surface of the tumor will suffice; in another in which fulguration, resection, or surface application of radium is not applicable, implantation of radium in the form of needles or as the emanation will yield results in cases hopeless to any other form of therapy.

It has usually been our custom in the classification of bladder tumors to differentiate one tumor from another histologically. Thus papillomata were divided into the benign and malignant types. In the former group were included those tumors in which the epithelium lining the connective tissue axis had a palisade arrangement at the base, above which were several layers of oval, long-tailed cells, all of which were of uniform size and shape and took the stain with uniform intensity. The papilloma was considered malignant when this uniformity in the size, shape, and staining characteristics was lacking or when the connective tissue axes of the tumor were infiltrated.

When infiltration of the pedicle of the tumor or the bladder wall was present, the tumor was no longer regarded as a papilloma but was termed a papillary carcinoma. It should be noted, however, that in many of these malignant types of tumor, particularly the malignant papilloma, many portions of the tumor, often the major part,

[1] Read at the annual meeting of the American Association of Genito-Urinary Surgeons, Washington, May, 1928.

presented a perfectly benign appearance histologically. On the other hand, it was occasionally observed that in an apparently benign tumor a careful and painstaking search would finally establish a malignant character. In many of these cases, therefore, where a single block of tumor tissue was removed for section, a diagnosis of the benign type was made, whereas, if other specimens of the tumor had been examined, definite histological proof of malignancy would have been forthcoming.

The classification to be adopted in this paper is not one based upon the histology of tumors, as this has proved in our experience to be of very little practical value. The difference histologically between the benign and malignant papilloma is of no practical value. Both types of tumor will usually respond equally well to the same type of therapy. The only practical advantage of this differentiation is that one can predict somewhat more accurately that there will be a greater tendency to recurrence in the case of the malignant papilloma. A section of the flat, non-infiltrating, papillary carcinoma may not differ at all from the histological picture presented by the tissue obtained from the surface of the papillary tumor the base of which is deeply infiltrating. If one were to depend upon the histological picture alone, the form of therapy successful in the one case should be equally successful in the other. Our practical experience, however, has shown distinctly that this is not true. Radium applied to the surface of the non-infiltrating papillary carcinoma will usually effect its removal but when applied to the deeply infiltrating tumor, it has been found to be entirely useless and even harmful.

In a long series of cases, pieces of tumor were removed in all cases in which this was possible and the histological picture was compared with the cystoscopic appearance of the tumor. It was observed that the data obtained from careful cystoscopy, symptoms, and palpation furnished very much more reliable information as an aid to the selection of the form of therapy which would yield the best results.

The pathologist can tell us with more or less accuracy whether or not the tumor is of the benign or malignant type. He cannot, however, tell us the degree of malignancy nor the extent and degree of involvement. This information is more accurately furnished by the cystoscope. The pathologist rarely furnishes any information of value to aid the urologist in the selection of the therapeutic procedure best adapted to any given case.

It is proposed that from the standpoint of therapy, bladder tumors be divided into two general groups, the differentiation being based upon the presence or absence of infiltration of the tumor pedicle or bladder wall. While errors in interpretation are bound to occur, our statistics show that untreated tumors which are clean and vascular and not associated with cystitis or evidences of œdema about their bases, should be regarded provisionally at least as non-infiltrating and treated by endovesical therapy. These tumors which will include papillomata and the clean vascular, sessile type of papillary carcinoma are usually not very difficult to recognize. The same may be said of the more extensive infiltrating tumors. The greatest difficulty in a correct cystoscopic interpretation will be presented by tumors in which the infiltration is confined to the pedicle or extends only superficially into the bladder wall, or in which because of the size of the tumor, inspection of the mucosa contiguous to the pedicle is impossible. However, in this particular group of tumors, in which there is uncertainty as to the degree of involvement, it has been our custom to regard them as belonging to the non-infiltrating type and treat them accordingly. If they respond to this treatment, well and good; if they do not, little has been lost, for it is generally believed that there is slight risk of early metastasis in superficially infiltrating tumors.

Practically all of the non-infiltrating types of tumor will respond to the so-called endovesical methods of treatment which consist of fulguration, the application of radium to the surface of the tumor, and to a combination of these two procedures. Most of the papillomatous tumors will respond to fulguration alone. There are certain tumors of this group, however, which are resistant to this method of treatment and it is our custom in all papillomata, except the villous type, to give from 300 to 600 milligram hours of surface radium preliminary to fulguration, as experience has shown that the tumor is thereby rendered more vulnerable to the procedure.

In one of our early cases in which a histological study had resulted in a diagnosis of malignant papilloma, the value of preliminary radiation was most convincing and led to the very frequent employment of this therapeutic measure combined with fulguration in the papillomatous types of tumor. This patient was first treated by fulguration at monthly intervals for a period of about 6 months. At each treatment the tumor which was 1½ centimeters in diameter was vigorously fulgurated and apparently completely

destroyed. At the next cystoscopy, however, the tumor gave no evidence of ever having been treated, being of the same size and appearance as noted originally. After 6 months of fulguration, 5 hourly treatments of 100 milligrams of radium applied to the surface of the tumor were followed by vigorous fulguration which resulted in its eradication. The patient died of pneumonia 4 months later and a careful autopsy gave no evidence of recurrence or metastasis.

If on the initial cystoscopy, surface necrosis is noted in a previously untreated tumor or if a tumor has been subjected to fulguration and the slough fails to separate promptly the tumor should be regarded as infiltrating and not suitable for endovesical therapy. The proper method of attack will often differ with the personal preference of the operator, but most authorities are agreed and our statistics support the conclusion, that resection with a wide margin of healthy bladder wall will give the best results.

Thus in 68 cases of cancer of the bladder in which resection was carried out, there were 6 postoperative deaths. Twenty of the patients, or 32 per cent, were well for 1 year or more, while 13 or 20 per cent remained well for 5 or more years. It is interesting that in this series of 68 cases, the ureter was transplanted 15 times. In this latter group, there were 6 or 40 per cent cures, 4 of the patients being alive and well 9 years after operation and 2 dying from other causes several years after resection.

Multiplicity of the tumor or involvement of the trigone or vesical orifice may render resection impossible and a choice between radium implantation or diathermy must be made.

While our experience in the use of diathermy in the treatment of infiltrating tumors of the bladder is so limited that it is unfair to draw any definite conclusions regarding its relative value, our personal preference inclines us to employ radium implantation in these cases. The technique we have followed consists first in free mobilization of the bladder followed by a surface destruction of the tumor by means of cautery, thus diminishing the likelihood of tumor implants. Platinum points, each containing 1 milligram of radium element, are then plunged into the base of the tumor, 1 milligram being used for each square centimeter of tumor surface. In cases of extensive malignancy, particularly if the vesical orifice be involved, the small points are re-inforced by spears each containing 10 or 12½ milligrams of radium element. The radium is allowed to remain *in situ* for from 24 to 48 hours depending upon the degree of bladder-wall involvement. In this way a radiation totaling 1200 to 2400 milligram hours can be obtained. In 34 cases of bladder cancer in which this technique was employed, 6 patients (17 per cent) were well for 1 year or more.

The employment of cautery in the treatment of bladder tumors should be limited to the surface destruction of the tumor preliminary to resection or implantation of radium. That this therapy will succeed in destroying superficial neoplasms is undoubted, but this type of tumor is best and most safely handled by endovesical means.

In recent years many claims have been advanced favoring deep X-ray therapy. In our experience, this agent has been of greatest value in ameliorating the pains of nerve involvement. In 10 cases of extensive and deeply infiltrating tumor, this method alone was employed and in none of these cases was any marked improvement noted. In 37 other cases receiving radium and deep X-ray in combination, an apparent cure was obtained. It seems apparent, therefore, that this form of therapy is most effective if the tumor is first subjected to a series of radium treatments.

CONCLUSIONS

Much of the confusion in the past regarding the most appropriate treatment to be applied to any given case of bladder tumor is the result of the present classification which is based upon the histological findings in fragments removed by cystoscopic means. We have repeatedly demonstrated the great possibility of error in basing a diagnosis upon the histological study of a single specimen thus obtained.

In so far as the so-called papillomata are concerned, the differentiation between benign and malignant forms is of no practical import from the standpoint of therapy as both respond to a combination of radium and fulguration.

In case of the so-called papillary carcinoma, greater confusion is present as the non-infiltrating tumor of this type may present a histological picture identical with the tissue obtained from the surface of a tumor the base of which has extensively infiltrated the bladder wall. An early differentiation of these two types of tumor is most essential as the former usually responds to surface application of radium and the latter requires an extensive surgical procedure.

It is believed that much of the confusion created by the histological classification will be obviated by replacing it with one based upon the cystoscopic findings alone. Under this classification, tumors would be designated as either non-infiltrating or infiltrating. The experienced cystoscopist will usually have little difficulty in making

this differentiation. In border-line cases, however, the tumor should be regarded, tentatively, as non-infiltrating and treated accordingly.

Experience has shown that practically all of the non-infiltrating tumors will respond to endovesical (cystoscopic) measures, consisting of radium and fulguration alone or in combination. In the infiltrating type these methods are contraindicated.

All of the infiltrating tumors so situated as to permit resection should be so treated even though transplantation of the ureter will be necessary. However, in other tumors which are too extensive or which involve the vesical orifice and the prostate, the implantation of radium is recommended.

NOTE.—The statistics cited in this paper are taken from the excellent review made by Drs. W. W. Scott and Robert McKay of 622 cases of bladder tumor treated at the Brady Urological Clinic. Their paper appeared in the *New York State Journal of Medicine*, 1927, xxvii, 939–949. The author takes pleasure in acknowledging his indebtedness to these gentlemen.

ACUTE INTESTINAL OBSTRUCTION DUE TO IMPACTED GALL STONES

REPORT OF FOUR CASES

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A LARGE impacted gall stone is too seldom considered as an etiological factor in acute intestinal obstruction. By no means rare, the condition occurs with sufficient frequency to merit attention. The first recorded case is that of Bartholin (1) in 1654. The monumental work of Courvoisier (4) contains an admirable analysis of all the reported cases prior to 1890. Wagner (12) made an exhaustive study of the literature in 1914 and collected and tabulated 334 cases.

The 4 cases herewith reported occurred in 179 patients operated on for intestinal obstruction at the Peter Bent Brigham Hospital during the past 14 years. The frequency of obstruction by gall stones in this series is 1 in 45 or 2.2 per cent. This figure agrees with that of Moore (8) who estimated from all the available statistics that between 1 and 2 per cent of all cases of intestinal obstruction are due to gall stones. It is not in accordance with the earlier and somewhat higher estimate of Courvoisier.

For purposes of comparison, all the cases of intestinal obstruction at this hospital have been tabulated on the basis of etiology, age of the patient, morbidity, and mortality (Table 1).

The mechanism by which the gall stone reaches the gastro-intestinal tract has been carefully studied. The process begins with cholecystitis and cholelithiasis, followed by ulceration, erosion, and pericholecystitis. Adhesions form between the gall bladder or ducts and the surrounding viscera, and perforation occurs within the adhesions. Occasional fistulæ have been observed at operation with a large stone lying partly in the gall bladder and partly in the duodenum. By far the largest number of perforations occur between these two organs. Fistulæ have been found, however, between the gall bladder and the stomach, jejunum, ileum, colon, and urinary bladder; also between the common duct and stomach or duodenum. Borroud, quoted by Martin (7), reported a case in which 200 stones were passed by the urethra within a period of 8 days and the patient recovered. Elsner (6) published a report of a case in which postmortem

TABLE I.—AN ANALYSIS OF ALL THE CASES OF INTESTINAL OBSTRUCTION AT THE PETER BENT BRIGHAM HOSPITAL.

Cause	Number of cases	Average age of patients	Number of deaths	Morbidity in %	Mortality % of morbidity
Postoperative adhesions	55	35.9	21	31.0	38.2
Carcinoma of colon	36	58.6	15	20.2	41.7
Strangulated femoral hernia	11	61.6	4	6.3	36.4
Strangulated ventral hernia	10	52.5	5	5.6	50.0
Paralytic ileus	8	56.1	7	4.5	87.5
Strangulated inguinal hernia	8	53.1	2	4.5	25.0
Meckel's diverticulum	7	30.6	1	3.9	14.3
Volvulus	6	46.6	2	3.4	33.3
Congenital adhesions	6	45.2	1	3.4	16.6
Old inflammatory adhesions	5	48.4	2	2.8	40.0
Mesenteric thrombosis	5	45.4	3	2.8	60.0
Diverticulitis sigmoid	4	65.2	0	2.2	0.0
Internal concealed hernia	4	44.0	2	2.2	50.0
Impacted gall stones	4	61.4	1	2.2	25.0
Intussusception	3	20.3	0	1.7	0.0
Tuberculous peritonitis	2	36.5	1	1.1	50.0
Tuberculous stricture of jejunum	1	41.0	0	0.6	0.0
Carcinoma of jejunum	1	39.0	0	0.6	0.0
Carcinoma of prostate	1	58.0	1	0.6	100.0
Carcinoma of uterus	1	69.0	0	0.6	0.0
Constriction from superior mesenteric vessel	1	40.0	0	0.6	0.0

examination disclosed a sinus tract leading from the gall bladder to a perinephritic abscess which had subsequently extended to the kidney where 1 gall stone was found. Another had previously passed down the ureter to the bladder and been voided.

Perforations may occur without any attending symptoms. Reimann and Bloom (11) have published the autopsy findings of a patient who succumbed to empyema following lobar pneumonia. Although the patient was jaundiced, there was no previous history of gall-bladder disease. Postmortem examination revealed a biliary fistula between the gall bladder and pyloric portion of the stomach. A calculus about 1.5 centimeters in diameter was located in a small cystic cavity of the stomach wall completely separated from the lumen of the viscus.

Cases of intestinal obstruction by large gall stones are on record, however, in which no fistula existed and the only explanation is that the stone must have passed by way of the biliary ducts. Murphy (9) cited an instance in which the common duct was dilated sufficiently to allow the passage of a stone 4 inches in circumference. Morgagni, quoted by Martin, reported a case in which the common duct was dilated to the size of the stomach and filled with stones.

Approximately one-half the patients recover without operative aid. The stone is gradually forced onward through the small bowel into the colon and out through the rectum. Murphy states "of 125 cases, 70, after various and repeated colics, emesis, peritonitis, ileus, etc., were cured spontaneously by the passage of the stones per anum." In Wagner's series, 93 passed the stone by rectum, 159 were operated on, and 82 died without operation.

The importance of early diagnosis cannot be over emphasized. Martin states "the diagnosis of gall-stone ileus is seldom made with certainty." On the contrary, Murphy believes that "ileus due to a gall stone which has perforated through the gall bladder into the intestine may have no preceding jaundice but the inflammatory symptoms which accompany such a perforation ought to suggest the diagnosis." Three of the 4 cases recorded below presented symptoms characteristic of the type of indigestion which so frequently accompanies disease of the biliary system. A detailed inquiry into the past history usually will enable one to make a correct diagnosis.

The clinical picture is that of sudden, acute intestinal obstruction or recurrent attacks of partial obstruction. Visible peristalsis is rarely present. Local tenderness, as a rule, is not marked; sensitiveness beneath the right costal margin in the region of the gall bladder offers a valuable diagnostic clue in cases of recent perforation. Generalized abdominal spasm is indicative of general peritonitis.

Subcutaneous and intravenous administration of salt solution before operation forms a very important adjunct in treatment. Orr and Haden (10) have recently shown how seriously the body chlorides become depleted in patients with intestinal obstruction.

When toxæmia is marked, all supportive measures should be instituted before the patient is taken to the operating room.

The length and type of operative procedure depends entirely upon the patient's general physical condition. In a great many cases, removal of the stone and temporary enterostomy should suffice. This offers an additional advantage in allowing free drainage to the toxic intestinal contents retained above the point of obturation. If the bowel has been obstructed for only a short time, the intestine may be closed with safety. Cholecystectomy should seldom be considered. Many patients, relieved of their obstruction, die because of an unduly prolonged operative procedure. The gall bladder may be removed at a later date much more safely and conveniently. Entero-enterostomy should likewise be avoided if possible. Brown (3) advises removing the stone through a transverse incision in order to avoid such constriction of the intestinal lumen as occurs when a longitudinal incision is closed and inverted. Davis (5) suggests transverse closure of a longitudinal incision.

Statistics regarding the mortality are extremely variable. The following table is striking.

TABLE II.—A TABULATION OF THE MORTALITY REPORTED BY VARIOUS AUTHORS FOLLOWING OPERATIONS FOR INTESTINAL OBSTRUCTION BY GALL STONES.

Author	Number of operations	Mortality in percentage
Wagner	159	48
Courvoisier	125	44
Schuller	82	56
Hermann	82	63
Benning-Wilms	64	33
Honigman	34	47
Lobstein	31	61
Mœller	22	82
Naunyn	13	92

Although the majority of patients with acute intestinal obstruction by gall stones are stout women beyond middle life, there seems little excuse for such an astoundingly high mortality. It

is probable that many lives could be saved by making an early diagnosis, subjecting the patient to only the simplest operative procedure, and instituting proper supportive measures. Bennett (2) has reported 3 cases with no deaths. Wagner quotes Koerte as stating that all uncomplicated cases should recover. Of the 4 cases recorded here, 3 recovered and 1 died of renal insufficiency and hyperglycæmia.

REPORT OF CASES[1]

CASE 1. A married, white woman, 62 years of age, entered the hospital complaining of vomiting, of 3 days' duration.

Past history. Uterus, ovaries, and tubes had been removed 15 years previously because of irregular menstruation. During the past 18 months the patient had had occasional attacks of abdominal distress after meals, accompanied by belching of gas but no sour eructations, nausea, or vomiting. She had passed no clay-colored, bloody, or tarry stools. One year before admission she had an attack which began with dizziness and fainting followed by severe abdominal pain, some fever, and generalized soreness. She vomited for 3 days and remained in bed 1 week.

Present illness. Three days previous to admission the patient was awakened in the early morning with severe abdominal pain centered about the umbilicus. Thirty-six hours later she began to vomit and continued to do so at hourly intervals until admission. During the last 12 hours the vomitus had a definite fæcal odor. Two days before admission she was given an enema and passed a large, hard, gray stone; subsequent enemata were ineffectual.

Physical examination. The patient was a well developed, well preserved, pale, elderly woman, appearing distressed. She regurgitated upper abdominal contents at frequent intervals. Pupils were pin-point in size and inactive to light and accommodation. Heart and lungs were normal. The abdomen was level, soft, and tympanitic with slight fullness in the epigastrium; there were no masses, spasm, or tenderness. A low midline abdominal hernia was present at the site of the previous incision.

Clinical pathology. On admission the patient's temperature was 100, pulse rate, 96; respiratory rate, 28. Leucocyte count was 20,200; hemoglobin, 85 per cent; examination of the urine was negative except for a slight trace of acetone.

Pre-operative diagnosis. High intestinal obstruction due to impacted gall stone.

Operation. Removal of gall stone from jejunum for acute intestinal obstruction; repair of abdominal hernia; gas-oxygen and novocaine anæsthesia. The old scar was excised, a large hernia dissected, and the edges of the rectus fascia were refreshed. When the peritoneum was opened a small amount of free, brownish fluid was found in the peritoneal cavity. Small intestines in the lower abdomen were collapsed; in the upper abdomen they were considerably distended, rather thick-walled, and slightly injected. After some search a gall stone about 2 inches long and ¾ inch in diameter was found impacted in approximately the mid portion of the jejunum. Below this point the bowel was collapsed. A small facetted stone was also felt in the cæcum. Examination of the gall bladder showed it to be small, sclerosed, adherent to the duodenum, and surrounded by fresh adhesions. No stones could be felt. The loop of jejunum containing the stone was brought out through the wound and the stone removed through a longitudinal incision. The wound was repaired with a continuous inverting chromic suture through all coats and silk mattress stitches through the outer coat. Drainage was considered unnecessary. Omentum was replaced over the small intestine and the abdomen closed by overlapping the rectus fascia with mattress sutures of chromic catgut re-inforced by silkworm gut and silk to the skin. The patient left the operating room in good condition. The stone resembled a cast of the gall bladder and was of the rough cholesterin variety.

Postoperative course. The patient made a good convalescence and on the ninth day passed a gall stone in an enema. The wound healed by first intention. She was discharged well.

CASE 2. A married, white woman, 56 years of age, entered the hospital complaining of abdominal pain and vomiting, of 2 days' duration.

Past history. The patient was first admitted to the hospital 5 years previously because of progressive fatigue and gradual loss of weight. She was found to have hypertension and diabetes, was rendered sugar free, and placed on a maintenance diet. Two years later she suffered a right hemiplegia which gradually cleared up after several months. She was persistently constipated.

Present illness. Three weeks before admission she had an attack of indigestion characterized by generalized abdominal pain, nausea, and vomiting, which lasted 4 days. This was followed by anorexia and belching of quantities of gas. Two days before admission she was awakened in the early morning with frequent severe pains just above the umbilicus, lasting about 5 minutes and occurring at frequent intervals. During the next 48 hours the cramp-like pains persisted and she vomited everything taken by mouth. The vomitus had a foul odor. In spite of many cathartics, her bowels had not moved since the initial attack 3 weeks previously.

Physical examination. The patient was a moderately obese adult woman, lying quietly in bed. The face was flushed, mucous membranes were dry and tongue was coated. Heart and lungs were normal. The abdomen was soft and not distended; palpation was accomplished with ease and without discomfort to the patient. Pelvic examination revealed multiple small uterine fibroids. There was nothing abnormal by rectum.

Clinical pathology. On admission the patient's temperature was 98 degrees, pulse rate 120, respiratory rate 25. Leucocyte count was 7,300. The urine contained 1.3 per cent sugar, acetone and diacetic acid. Blood sugar was 0.44 per cent. Renal function test showed 17 per cent of the dye excreted in 2 hours and 10 minutes.

Sigmoidoscopy showed nothing abnormal. Barium enema filled the colon readily and showed no evidence of pathology. There were no signs of toxæmia but the patient continued to vomit about twice daily. Exploratory laparotomy was advised and accepted.

Pre-operative diagnosis. Intestinal obstruction of unknown cause.

Operation. Removal of gall stone from lower jejunum and Mixter enterostomy for intestinal obstruction; gas-oxygen and novocaine anæsthesia.

Incision was made in the lower mid-abdomen. When the peritoneum was opened a small amount of straw-colored fluid escaped. Presenting in the wound was a loop of small bowel distended to about 6 times its normal size. Examination of the pelvic viscera showed a small sessile uterus with several small fibroids on its surface. Descending, transverse, and ascending portions of the colon were collapsed. By following the dilated small bowel a loop of lower jejunum was found in which a hard ovoid mass was

[1] The first patient was operated on by Dr. John Homans, the second by Dr. H. F. Newton, the third by Dr. C. E. Bird, and the fourth by Dr. J. H. Powers.

firmly impacted. The intestine below this point was collapsed. Exploration of the upper abdomen revealed a mass of adhesions between the gall bladder and duodenum. The loop containing the calculus was delivered, walled off from the operative field and the stone removed through a small incision. A Mixter tube was sewed into the rent in the small bowel and the loop of intestine approximated to peritoneum by a few chromic sutures. When the Mixter forceps were removed a large amount of foul, fæcal-like substance escaped from the proximal intestine. A small cigarette drain was inserted through the peritoneum to the region of the operative field. The abdomen was closed with a few interrupted sutures in the peritoneum, chromic, re-inforced by silkworm gut in the fascia, and silk in the skin. The patient left the table in fair condition.

The specimen consisted of a large, brown gall stone measuring approximately 3.5 centimeters in diameter. On section it appeared to be made up of many layers of cholesterin.

Postoperative course. The patient made a fair recovery from the anæsthetic but became irrational on the first day after operation. The urine contained no sugar, diacetic acid, or acetone. She was given digitalis, glucose, and insulin. Systolic blood pressure fell to 80. On the second day she was nauseated and vomited several times. Drainage from the enterostomy was copious. On the third day she did not respond well; the skin was cold and clammy. The urine was still sugar free. Blood sugar was 0.51 per cent; blood urea nitrogen was 109 milligrams per 100 cubic centimeters. Digitalis, glucose, and insulin were continued. She died on the afternoon of the fourth postoperative day.

Necropsy. The gall bladder was shrunken and bound down to the liver and duodenum by many firm, fibrous adhesions. The wall was thick and the mucosa necrotic. There was a pocket about the size of a walnut which had contained a large solitary stone. An opening was found between the duodenum and the lumen of the gall bladder. A small probe could be passed into the pancreatic and hepatic ducts but the cystic duct was entirely fibrosed. A small, irregular stone was found in the gall bladder near the beginning of the cystic duct.

The duodenum was opened *in situ;* a low-grade duodenitis was present. The mucosal surface was injected, œdematous, and stained with bile. A small acute duodenal ulcer, 1 centimeter in diameter, was found on the posterior wall about 6 centimeters beyond the pylorus.

CASE 3. A widow, aged 72 years, was admitted to the hospital complaining of spasmodic abdominal pain and vomiting.

Past history. For 10 years the patient had been subject to mild "indigestion" characterized by belching of gas, sour eructations, slight pain in the epigastrium and right hypochondrium. These attacks bore no relation to meals. Eight months previous to admission she had one transient attack of sharp, knife-like pain in the right upper quadrant of the abdomen beneath the costal margin, accompanied by nausea and vomiting. She had never passed tarry, bloody, or clay-colored stools nor been jaundiced.

Present illness. Three days before admission the patient was suddenly seized with severe epigastric pain and vomiting. The pain was cramp-like in character and recurred every few minutes until she entered the hospital. At first the vomitus consisted of recently eaten food but later changed to brownish watery fluid. There was no fæcal odor. Her bowels moved normally on the night before the onset of the present illness. Subsequently she passed no fæcal material but a small amount of flatus with the aid of enemata.

Physical examination. The patient was a well developed and preserved elderly woman lying in bed in some discomfort. She regurgitated thin, brownish, sweetly-smelling material from her stomach every few minutes without retching and occasionally cried out with pain. Heart and lungs were normal. Abdomen was slightly distended but showed no visible peristalsis or localized swelling. There was diffuse tenderness, most marked around and just above the umbilicus. The left lower quadrant was dull to percussion. No masses were palpable. During the interval between pains there was no spasm of the abdominal musculature.

Clinical pathology. On admission the patient had a temperature of 96.4 degrees; pulse rate was 112; respiratory rate, 28. Leucocyte count was 9,400; hæmoglobin, 90 per cent. Urine showed an occasional erythrocyte and a few leucocytes per high power field.

Pre-operative diagnosis. Acute intestinal obstruction due to impacted gall stone; chronic cholecystitis, and cholelithiasis.

Operation. Removal of impacted gall stone from terminal ileum for acute intestinal obstruction; incidental appendicectomy under ether anæsthesia.

The abdomen was opened through a right paramedian incision. Normal appearing transverse colon presented; there was a moderately dilated loop of small bowel below it. In the right iliac fossa, a large gall stone was found impacted in the terminal ileum against the ileocæcal valve. Proximal ileum was dilated. The stone was milked gently upward for a short distance, the loop containing the stone delivered into the wound and carefully walled off from the operative field. Enterostomy clamps were lightly applied above and below and the stone removed through a longitudinal incision. The bowel was repaired with a continuous stitch of zero-chromic catgut through the mucosa and submucosa, re-inforced by a similar stitch including all layers except the mucosa. A normal appearing appendix was then removed in the usual manner. The upper abdomen was explored and a very hard mass felt beneath the right costal margin. This consisted of a thick sclerosed gall bladder containing multiple calculi and adherent to the duodenum and stomach. The abdomen was closed without drainage. The patient was in excellent condition. The calculus was about 2 centimeters in diameter, cubical, and had large facettes on two sides.

Postoperative course. The patient ran a slightly irregular elevation in temperature for 1 week and occasionally regurgitated fluid and food. The pulse rate rapidly subsided to normal. The wound healed *per primam.* On the fifteenth postoperative day roentgenological studies of the gastrointestinal tract showed a small hypertonic stomach. The duodenal cap filled well and emptied freely. There were several indistinct shadows just above the pylorus which were suggestive of gall stones. No further surgery seemed advisable at that time and the patient was discharged.

CASE 4. A married, white woman, 56 years of age, entered the hospital complaining of abdominal pain and vomiting.

Past history. The patient had rheumatic fever when she was 13 years old and typhoid fever 11 years later. Appendicectomy was performed for acute appendicitis at the age of 43 and the abdomen was drained. For many years she had suffered with dull pain and distress in the epigastrium, gaseous and sour eructations, coming on after meals and not relieved by food. During the year previous to the present admission these symptoms had become much more frequent and persistent. She had never been jaundiced and had passed no bloody, tarry, or clay-colored stools. Her bowels moved daily without catharsis.

Present illness. The attack began 2 days before admission with a dull, gnawing pain in the epigastrium which gradually became so severe that the patient shrieked with agony. Vomiting commenced and continued at hourly

intervals. Each spasm was preceded by very sharp, cramp-like pain in the epigastrium, radiating to the umbilicus and right lower abdomen. The vomitus had a fæcal odor. Her bowels moved normally before the onset of the illness; subsequently she passed only one small hard stool.

Physical examination. The patient was a well developed and nourished, middle aged woman lying quietly in bed in no apparent distress. Cheeks were flushed, tongue was dry and moderately coated. Heart and lungs were normal. The abdomen was slightly distended and tympanitic except in the flanks; there was no visible persistalsis, no shifting dullness or fluid wave. The scar of the previous operation was present in the right lower quadrant. There was moderate tenderness throughout the upper abdomen, more pronounced on the right side, slight tenderness around the old scar, and marked tenderness over the descending colon and sigmoid. No masses were palpable. Pelvic and rectal examinations were negative.

Clinical pathology. Temperature on admission was 99.0 degrees; pulse rate, 80; respiratory rate, 20. Leucocyte count was 13,000. The urine was normal except for the presence of indican.

Pre-operative diagnosis. Acute intestinal obstruction due to large gall stone impacted in the small intestine.

Operation. Removal of gall stone from ileum for acute intestinal obstruction; gas-oxygen, ether, and novocaine anæsthesia.

The patient was given 1500 cubic centimeters of 1 per cent salt solution by hypodermoclysis and 500 cubic centimeters of 5 per cent salt solution intravenously. The abdomen was opened through a low right rectus incision, excising the old scar. Multiple coils of tense, distended small intestine presented. Eventually a loop containing a hard mass was found and delivered into the wound. Proximal bowel was red, dilated, and inflamed; distally the intestine was normal in appearance, and collapsed. The loop was carefully walled off from the operative field and the calculus removed through a longitudinal incision directly over it. The rent was closed by a continuous suture of zero chromic catgut through all layers and an additional row of inverting mattress sutures including the submucosa. The abdomen was not explored. Closure was carried out in the usual way without drainage. The patient stood the procedure well and left the operating room in good condition. The calculus was a large, bullet-shaped gall stone, 3.5 centimeters long and 2.5 centimeters in diameter. It appeared to be a cast of the fundus of the gall bladder; the flat end was facetted.

Postoperative course. Temperature, pulse, and respiration were normal on the third day. There was no nausea or vomiting. Bowels moved normally after the fourth day. The wound became superficially infected, was opened, treated with Dakin's solution, and healed by second intention. The patient was discharged improved.

COMMENT

In the first case the diagnosis of intestinal obstruction by an impacted gall stone was obvious. Perforation undoubtedly occurred during the attack of abdominal pain and vomiting one year previous to admission. It is well known that a gall stone may lie dormant in the intestinal tract for some time without causing any symptoms. The second patient presented no past history referable to disease of the gall bladder and an accurate diagnosis was impossible. She did not succumb to the toxæmia of intestinal obstruction but to hyperglycæmia and renal insufficiency. The third case illustrates the importance of an accurate interpretation of the past history. Although no characteristic pain or jaundice had ever been present, the type of indigestion which the patient described was entirely compatible with that which so frequently accompanies chronic cholecystitis and cholelithiasis. In the fourth case it was necessary to differentiate between an impacted gall stone and adhesions at the site of the old operative wound. A detailed analysis of the past history turned the balance of evidence in favor of the former diagnosis.

CONCLUSIONS

Cases of acute intestinal obstruction by impacted gall stones are not infrequent. The stone reaches the intestinal tract either through a perforation within adhesions between the gall bladder and some neighboring viscus or by way of the biliary ducts. The clinical picture is that of acute intestinal obstruction engrafted upon a previous history of cholecystitis and cholelithiasis. Although a certain number of patients are cured spontaneously by passage of the stone, the danger of peritonitis is great and operative aid should be administered early. The stone should always be removed and the subsequent operative procedure limited to accord with the patient's general condition. Subcutaneous and intravenous administration of saline solution is of distinct value in combating toxæmia.

BIBLIOGRAPHY

1. Bartholin. Quoted by Martin.
2. Bennett, C. Obstruction of small intestines by gall stones. Brit. M. J., 1926, i, 565.
3. Brown, J. S. Gall-stone ileus. Surg. Gynec. & Obst., 1913, xvi, 709.
4. Courvoisier. Casuistisch-Statistische Beitrage zur Pathologie und Chirurgie der Gallenwege. Leipsig, 1890.
5. Davis, N. P. Acute intestinal obstruction by a gall stone. Atlantic M. J., 1925, xxix, 778.
6. Elsner, H. L. The vagaries and wanderings of gall stones. Med. News, 1898, lxxii, 64.
7. Martin, F. Intestinal obstruction due to gall stones. Ann. Surg., 1912, lv, 725.
8. Moore, G. A. Gall-stone ileus. Boston M. & J., 1925, cxcii, 1051.
9. Murphy, J. Gall-stone disease and its relation to intestinal obstruction. Illinois M. J., 1910, xviii, 272.
10. Orr and Haden. Chloride treatment of intestinal obstruction. South. M. J., April, 1926, 300.
11. Reimann, S. P., and Bloom, G. H. Gall stone ulcerating into and lodging in the stomach. Proc. Path. Soc. Phila., 1918, xxi, 4.
12. Wagner, A. Ileus durch Gallensteine. Deutsche Ztschr. f. Chir., 1914, cxxx, 353.

EDITORIALS

SURGERY, GYNECOLOGY AND OBSTETRICS

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SEPTEMBER, 1928

ACCUMULATED BILE DISPLACING THE LIVER

SUDDEN changes in intra-abdominal pressure may occur secondary to operative procedures altering the relative position of the intra-abdominal viscera sufficiently to produce a train of events which, unless relieved, may risk or take the patient's life. Acute abdominal distention is frequently associated with an increasing pulse rate, lowering of blood pressure, cold and sometimes cyanotic extremities, evidences of circulatory disturbances of considerable magnitude.[1] Relief of distention by resumption of intestinal motility, whether spontaneously or induced by enterostomy or cæcostomy, is usually associated with and followed by a return of the circulation to normal, provided the factor of peritonitis does not exist. Sudden increases in intra-abdominal pressure resist excursions of the diaphragm, and respirations are labored and increased. Here again, with the relief of the abdominal distention and a return of intra-abdominal pressure to normal limits, breathing becomes easier and the rate of respiration is decreased.

Such changes are rare, however, in the relatively innocuous chronic abdominal distention occurring with abdominal ascites, ovarian and pancreatic cysts and subdiaphragmatic abscesses, the accumulation of which is slow enough to permit compensation for visceral displacements. Time and physiological adjustment play an important rôle also in the toxæmia of duodenal fistula and duodenal stasis. Active and intense in the acute stage, it disappears as the condition becomes chronic.

It should not be assumed that circulatory and respiratory changes occurring in such cases are due alone to alterations in intra-abdominal pressure or to changes in the relative position of intra-abdominal viscera, for the effect of causative factors in intestinal stasis and the toxæmia accompanying interference with intestinal motility without distention interjects elements which are difficult to interpret and may differ in each case.

Occasion presented to study the effect of displacement of an intra-abdominal viscus in a deeply jaundiced patient in whom the factor of causation was known and disturbances in intestinal motility did not exist. From 500 to 700 cubic centimeters of bile accumulated between the diaphragm and liver within 12 hours immediately following an anastomosis between the stump of the common bile duct and an opening made in the duodenum for the relief of a stricture involving the lower portion of the common bile duct. An accurate anastomosis was possible because the common bile duct proximal to the stricture was about three times normal size. In the

[1] Hunt, V. C. Cæcostomy for Paralytic ileus following extraperitonea operations. Surg., Gynec., & Obst., 1927, xliv, 271-272.

dissection of the stump of the duct from the under surface of the liver preparatory to making the anastomosis, a small nick was made in the duct near the hilum of the liver, which was immediately closed with suture. This was probably the point of exit of bile. Although the area of the anastomosis was drained, sufficient bile accumulated between the diaphragm and the liver to cause displacement of the latter.

A syndrome characterized by an exceedingly rapid pulse rate, low blood pressure, a rapid rate of respiration, a cold damp skin and semiconsciousness resulted from the downward displacement of the liver producing in turn interference with circulation in the inferior vena cava. With the patient in such condition, opening of the abdominal incision in the patient's room was rewarded by the gushing discharge of bile from the area between the dome of the liver and the diaphragm. Immediate improvement characterized by a drop of pulse rate from 165 to 115, a decrease in respiratory rate and a return to consciousness occurred in a few hours. From this time on convalescence was not complicated and complete recovery finally resulted.

Experimentally it was shown that downward displacement of the liver produces disturbances of the circulation in the inferior vena cava resulting in changes in blood pressure, pulse rate and respiratory rate similar to those which occurred in the patient. Furthermore, the removal of the factors displacing the liver was followed both clinically and experimentally by the return to normal of the pulse rate, blood pressure, respiratory rate, and by rapid and striking improvement in the general condition.[1]

WALTMAN WALTERS, M.D.

[1] Walters, Waltman, and Bollman, J. L. Results of accumulations of bile around the liver. J. Am. M. Ass. (In Press).

THE EARLY TREATMENT OF FRACTURES

TECHNIQUE of operations and improvements in methods of treatment have a strong influence on end-results but of far greater importance in many morbid conditions are early diagnosis and prompt action. The history of acute appendicitis and perforated gastric and duodenal ulcer illustrates this very definitely. More recently we have seen great improvements in the end-results of fractures. Much has been accomplished in the refinement of methods. The use of traction and suspension, and a clearer understanding of the advantages and dangers of open treatment have contributed to bettering our results. But the main reason why the disability following these injuries is decreasing, is that the medical profession and the public are realizing the importance of immediate action. In an overwhelming majority of cases today, the first entry in our records shows that "– hours or – minutes ago, patient fell, etc." instead of "– days." We are understanding better what takes place at the site of fracture during the early hours and days after injury. We are realizing that the golden opportunity for anything like exact approximation of fragments is limited to that period *before* the process of repair in both bone and soft parts has really started. We have seen cases in which the attendant at the playground or the policeman in the park has accomplished a reduction which the experts might have failed to produce the next day. No longer do we "wait for the swelling to go down"—that terrible advice which came down through so many blind generations—but proceed immediately to restore as far as we can the normal contour of the bones. Fractures are being regarded as emergency cases and given precedence over other less immediate problems.

With the appreciation of what can be accomplished in the early hours, we are also becoming less tolerant of improper reductions. Many a "satisfactory reduction" of twenty years ago no longer passes muster but repeated or prolonged attempts are made. We may have to accept some shortening in oblique or spiral or badly comminuted fractures but any overriding in a transverse fracture demands explanation.

Another reason for improvement in results is that, with the more exact knowledge of the details provided by the X-ray, our attempts at reduction are much gentler than they were when the external signs and symptoms were our only guides. We no longer proceed by rule of thumb but make our manipulations along definite lines. With more exact knowledge of just what we wish to accomplish we are able to proceed with less additional trauma to the ends of bones and to soft parts.

Lastly, improved results can be attributed to a more definite realization of the fact that the soft parts are injured as well as the bone; that treatment which is good for one, is often bad for the other; and that the maintenance of function of the muscles and joints during the period of repair of the bone will decrease both the amount and the duration of disability.

More prompt action, more exact replacement of fragments by gentler means, and more careful attention to soft parts are improving results.

The public is learning to come more promptly for help, and we medical men are appreciating more clearly what we can do. Nevertheless, until this modern attitude is still more widely adopted, the results of improperly treated fractures will continue to be blots on the escutcheon of American surgery.

WILLIAM DARRACH.

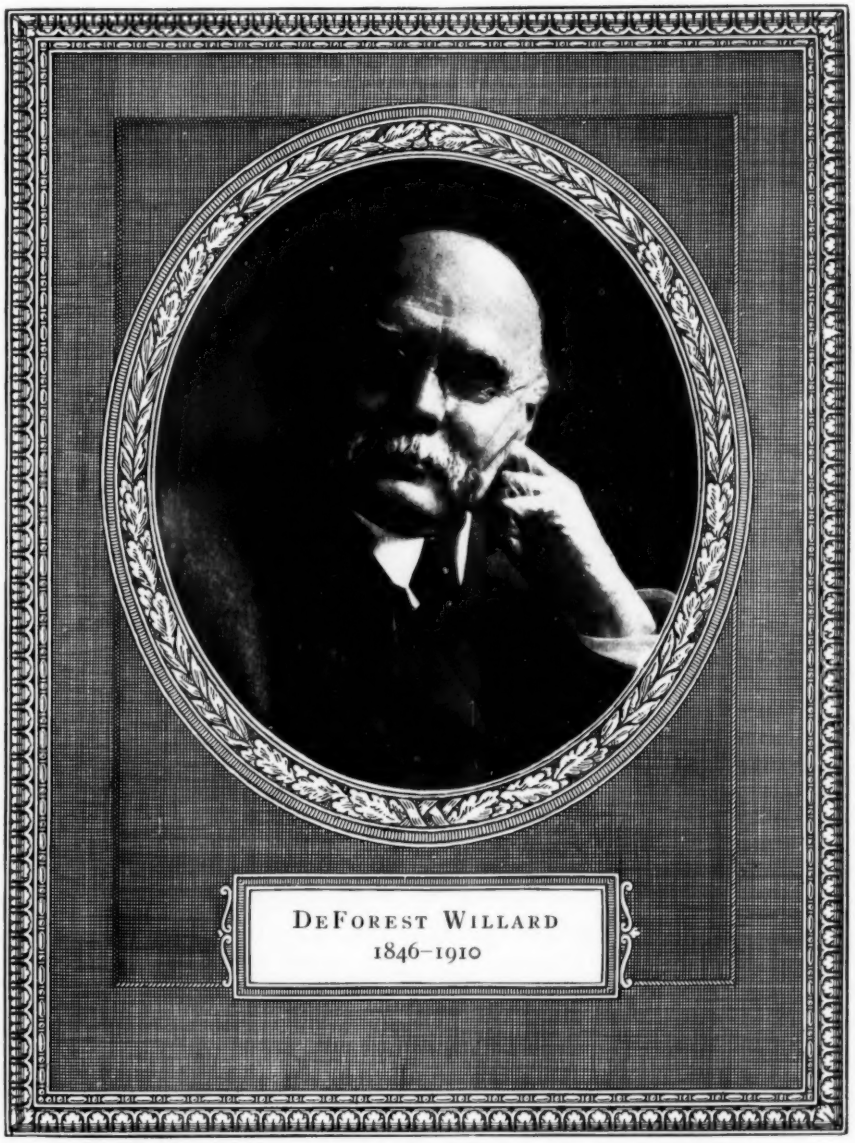
MASTER SURGEONS OF AMERICA

DeFOREST WILLARD

AMONG Pennsylvania's most noted surgeons was the late DeForest Willard of Philadelphia. Dr. Willard's family came to this country in 1637. His first American ancestor, Major Simon Willard, was one of the founders of the city of Concord, Massachusetts, and was the first commander-in-chief of the British forces in America. Of his ancestors, one was provost of Canterbury in 1218, and another was baron of Cinqueporte in 1477. Dr. Willard was also in direct descent of the third and the fifth presidents of Harvard College. From Massachusetts his branch of the family came to Connecticut; the settlement in Newington being made by the grandson of Major Simon Willard.

Dr. Willard was the son of Daniel H. and Sarah Maria (Deming) Willard, and was born at Newington, March 23, 1846. He graduated from Hartford High School in 1863. He passed his entrance examination to Yale College, but was unable to take up his college course on account of difficulty with his eyes. In 1864 he attended Jefferson Medical College in Philadelphia for one year. He was denied admission to the United States Hospital service during the Civil War on account of his lameness, but was accepted by the United States Sanitary Commission, and saw service at the siege of St. Petersburg in 1865. At that time he was placed in charge of a ward at the Army Hospital at City Point, and performed all the services of a full surgeon. In 1867 he received the degree of doctor of Medicine from the University of Pennsylvania, and was resident physician to the Philadelphia General Hospital for the next eighteen months. In 1869 he was appointed instructor in the University of Pennsylvania Medical School, and from that time until his death he served the University as demonstrator, quizmaster, associate professor and professor. The chair of orthopedic surgery was created for him in 1889.

During his lifetime Dr. Willard held many high positions in hospital, medical, and scientific associations. He was chairman of the surgical section of the American Medical Association, president of the American Orthopedic Association, president of the Philadelphia County Medical Society, and president of the Medical Board of the Presbyterian Hospital. He was also vice-president of the International Congress of Tuberculosis in 1908. He organized and founded the Orthopedic Department of the University Hospital, and this department is now



DeForest Willard
1846–1910

known by his name. He was organizer and surgeon-in-chief of the Widener Memorial Home for Crippled Children; surgeon to the University, Presbyterian, Germantown, Jewish, and Municipal Hospitals; consulting surgeon to the Atlantic City Hospital, Children's Seashore Home, Home for Incurables, and Home of the Merciful Saviour. In 1876 he was assistant medical director to the United States Centennial Exhibition in Philadelphia.

In addition to his purely professional work, he was on the board of managers of the University Hospital, Pennsylvania Training School for the Feeble-Minded, Union Benevolent Association, Academy of Natural Sciences, New England Society, and the Young Men's Christian Association.

Dr. Willard was a voluminous contributor to medical literature, most of his writings dealing with the specialty of Orthopedic Surgery in which he was most interested. Besides numerous other articles he wrote the chapters on Orthopedic Surgery for the Ashhurst International Encyclopedia of Surgery, and in 1910 published his book on the *Surgery of Childhood*, which is considered an authority on the subjects of which it treats.

Dr. Willard was never known to neglect any of the offices or the many positions which he held in his long career. He possessed an unusual degree of surgical judgment and operative skill to which was added a remarkable personal magnetism. Among his university students he was beloved because of his high ideals and constant kindness.

He received the honorary degree of A.M. from Lafayette College in 1882 and Ph.D. degree in 1885. He was married September 13, 1881, to Elizabeth M. Porter, daughter of the Honorable William A. Porter and Emma (Wagener) Porter. Dr. Willard died at his country home at Lansdowne, Pennsylvania, on October 14, 1910.

DeFOREST P. WILLARD.

THE SURGEON'S LIBRARY

OLD MASTERPIECES IN SURGERY

By ALFRED BROWN, M.D., F.A.C.S., Omaha, Nebraska

THE TETRABIBLION OF AETIUS OF AMIDA

IN the little town of Amida in the valley of the upper Tigris River, situated in Mesopotamia somewhat east of Cappadocea, northeast of Ur of the Chaldees, and southwest of Mount Ararat, Aetius was born; probably in the early part of the sixth century. The locality was famous at this period and its history goes back far into ancient times being important in Old Testament days, for if one looks at an old Biblical map he will find near it Nineveh, Caesarea, Mount Ararat, the upper Euphrates River, and many other names made familiar by the ever new Bible stories. More than this, the city has persisted to modern times. Becoming a Roman colonial town in the third century it was sacked by Timur the Tartar known as "Timur the lame," the Tamerlane of the plays, toward the close of the fourteenth century and captured by the Turks in 1515. It is now a part of Asiatic Turkey, known as Diarbekir or Kara Amid, and is noted for its output of beautiful morocco.

In the days of Aetius the city of Amida was subject to Rome. Constantine the Great had declared Christianity the religion of the State and transferred the court to Byzantium. In this way great impetus to growth was afforded Asia Minor, and once more this land, associated with ancient history, flourished with renewed importance and what there was of art, and science, and literature was distributed over that portion of the world reaching from Constantinople southeast through Asia Minor and thence westward to Alexandria. As the temporal power and its court was derived from the methods of ancient Greece and Rome, so science came from the same source and consisted largely of inherited ideas with little new added. The Roman Empire was dwindling and had really lost its power. A new world domination was coming on and under such circumstances the furtherance of scientific matters was not looked upon with great favor by the rulers.

Aetius was a Christian subject of the Emperor Justinian. He studied medicine at Alexandria, and after some years became closely connected with the court at Byzantium where he was the personal physician of the Emperor and an officer of the imperial household, and one of the great medical men of his time. His work is a compilation of the medical knowledge handed down from the ancient Greeks, modified by Celsus and Galen and, to a lesser extent, by his immediate predecessors and himself. In it he tries to cover all parts of medicine but does not pay a great deal of attention to surgery. He states, however, that he has explained some of the surgical work in another treatise, but this has never been found. Written in Greek, the work was first translated into Latin by Montanus and Cornarius and appeared in 1534. Subsequently, the entire work was translated into Latin by Janus Cornarius, who was born in Zwickau, was professor at Marburg and Jena, and is known principally for his Latin translations of the early Greek authors. This volume first appeared, published at Basle in 1542 by Froben; the Cornarius translation is also included in the *Medicae Artis Principes* of Henricus Stephanus (Henri Estienne) printed by Huldrich Fugger in 1567.

Aetius entitles his work *The Tetrabiblion*, the four books. Each of these is divided into four lesser books or sermons, thus making sixteen exhaustive books or chapters in all. He refers constantly to the authors from whom he draws, and the list is a long one. Surgery he mentions only as a side issue here and there. Little of his treatment is operative, but he does refer to ligation and torsion of vessels to stop hæmorrhage, and describes excision of hæmorrhoids. In bites of mad dogs he advises excision of the wound, free bleeding, and final cauterization. He notes the fear of drinking water among the symptoms, and the marked salivation causing foaming at the mouth.

Throughout the entire work the superstitious religious beliefs of the early Christians are evident. Salves and plasters are made to the accompaniment of prayers and incantations, and these same elements play a considerable part in therapy. When describing the method of removing a foreign body from the throat, Aetius says: "As soon as you have gotten the patient quiet and ordered him to listen to you, say: 'Come out bone (if it is a bone, or call it whatever it is) just as Jesus Christ drew Lazarus from the sepulchre and Jonah from the whale'; then, taking hold of the patient's throat say: 'Blasius the servant and martyr of Christ commands you—either come up or go down.'"

Aetius preserved for us the best of the work of the medical men of the early Christian Era and though not an original thinker like Paul of Aegina nevertheless he played an important rôle in medical history.

AETII MEDICI

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cum Latinè conſcripti.

BASILEAE M D XLII

REVIEWS OF NEW BOOKS IN SURGERY

SCHINZ and his collaborators[1] have written one of the most comprehensive and pretentious works on roentgen diagnosis that has ever been published. It covers the entire field, with exception of obstetrical and gynecological diagnosis, and incorporates most of the more recent developments in roentgenology. There is a wealth of detail contained in it, usually found only in books devoted to special branches of roentgen diagnosis. It is profusely illustrated with complete legends which in themselves offer a liberal course of instruction. The printing is excellent and the paper used tends to bring out the illustrations to the best advantage. Very little space is devoted to technical problems except where they have a direct bearing upon interpretation. Where a special technique is needed to render the roentgen examination effective, this is described in detail.

The section devoted to bones and joints deserves particular commendation. The roentgenographic findings of normal and abnormal conditions are correlated with the anatomical and pathological changes in a most instructive and valuable manner. Variations associated with progressive and retrograde changes are indicated. Articles on bone and joint lesions in infants are included by Hotz, and Looser has contributed chapters on chondrodystrophy, late rickets, osteomalacia, osteogenesis imperfecta, cysts and giant tumors, and cretinism.

Less detailed consideration has been given to lesions of the skull, mastoids, and paranasal sinuses. Ulrich has a good article on the sphenoid bone and internal ear and Juengling has covered the subject of ventriculography in a thorough and complete manner. Myelography with iodized oil is also discussed in detail. Foreign bodies in the eye are considered, but no mention is made of any exact methods of localization such as are commonly used in this country.

Lesions of the thorax are adequately covered and the chapters devoted to pulmonary tuberculosis are especially complete. The rôle which the roentgen examination plays in determining indications for operative procedures as well as the findings after operations on the lungs and chest wall are taken up at length. Ulrich has included the use of iodized oil in his contribution on the bronchi. Diseases of the lungs, pleura, large vessels, and mediastinum in adults are discussed by Liebman. Hotz has special articles on the heart in infants and on the thymus.

The normal anatomy, topography, and physiology of the various parts of the alimentary tract as far as they have a bearing on roentgen diagnosis are discussed exhaustively. Such pathological conditions as ulcer and cancer have received masterly consideration and the roentgen findings are discussed in relation to operations contemplated or completed. Hotz has contributed an article on the roentgen examination of the gastro-intestinal tract in infants, calling attention to the limited value of this method. The space devoted to the consideration of the appendix is exceedingly small and the value of the roentgen examination in connection with it minimized. Pneumoperitoneum is discussed as to indications and findings. Gall-bladder examinations are covered at length by the direct method as well as with the aid of the opaque meal and Graham-Cole test. A rather condensed, but, nevertheless, comprehensive discussion of the roentgen findings of the urinary tract completes the volume.

The book as a whole is a well conceived and elaborated exposition of roentgen diagnosis as generally accepted at the present time. It contains a fairly extensive bibliography appended to each special subject, made up largely of European authors. As a reference book it will form a valuable addition to any medical library.

ADOLPH HARTUNG.

HUNTER TOD'S book,[2] on diseases of the ear, revised by Cathcart is a very useful little volume. It is intended for senior students and general practitioners. The style and arrangement of material are very simple. The text is easy to read and the essentials on any subject are found without a great deal of searching. There are 4 very good colored plates. The 87 illustrations add a great deal to the forcefulness of the presentation.

The subject of inflammation in the middle ear is covered in 50 pages of this book of 325 pages. This important subject is treated in all of its essential points. Special attention is paid to otitis media in infants. It is stated, that in infants under 3 years of age postmortem examinations in a series of 100 cases have shown the presence of otitis media in 90 per cent of all cases in which it was not suspected in life.

Disease of the mastoid is covered in 45 pages. The technique of the mastoid operations is well described with the aid of drawings.

This book has accomplished the purpose for which it was written, but would be of small interest to the specialist.

ELLISON L. ROSS.

THE third part of the comprehensive work[3] on the surgery of the ear, nose, and throat by Moure, Liébault, and Canuyt has been published. The first

[1] LEHRBUCH DER ROENTGENDIAGNOSTIK MIT BESONDERER BERUECKSICHTIGUNG DER CHIRURGIE. Edited by H. R. Schinz in collaboration with W. Baensch and E. Friedl with contributions by A. Hotz, O. Juengling, E. Looser, and K. Ulrich. With a foreword by P. Clairmont and E. Payr. Leipzig: Georg Thieme, 1928.

[2] HUNTER TOD'S DISEASES OF THE EAR. Revised and largely rewritten by George C. Cathcart, M.A., M.D. 2d ed. New York: Oxford University Press, 1926.

[3] TECHNIQUE CHIRURGICALE OTO-RHINO-LARYNGOLOGIQUE. By E. J. Moure, G. Liébault, and G. Canuyt. Third part. Paris: Gaston Doin et Cie, 1928.

and second parts, on the ear, the nose, the accessory sinuses, and the nasopharynx, have already appeared. A fourth part on the larynx and œsophagus is in the press.

The desire of the authors has been to make the work a practical treatise on the mouth and pharynx —including the hypopharynx. In the surgical technique, they have limited themselves to typical operations and to those performed by Professor Moure at Bordeaux. They have included the indications and contra-indications as well as the necessary instruments to be employed, and due regard is given to complications that may arise. The illustrations are numerous and good.

The descriptions of the various diseases are marked by that brevity and clearness so characteristic of French medical writers. To give a typical example, one can point to the brief and concise description of septic phlegmon of the floor of the mouth (Ludwig's angina) which results in a picture one does not easily forget.

This is a volume the laryngologist and general surgeon will read with pleasure and will keep on hand for future reference. J. Gordon Wilson.

THE third edition[1] of Eden and Lockyer's *Gynæcology* is well arranged and accompanied by an adequate number of accurate illustrations.

The book is divided into three parts. Part I embraces descriptive anatomy, embryology, disorders of menstruation, tubal pregnancy, and the general subject of infections. This section is especially complete and very well presented. Menstrual disorders in particular are thoroughly discussed.

Part II is devoted to regional gynecology. It includes diseases of the external genitalia, the uterus, and the tubes and ovaries. Emphasis is placed on many subjects which are deemed of lesser importance by the modern American school of gynecology, but on the whole the presentations are attractive and accurate. More extensive consideration of the subject of endometriosis and less space devoted to endometritis would make a stronger appeal to the American reader.

Part III is devoted entirely to technique. The general principles of uniformly accepted procedures are well presented.

On the whole the text is clearly and concisely written and has been strengthened by revision. It will perhaps make a less strong appeal to the American gynecologist than to his English confrères.

Arthur H. Curtis.

THE author dedicates his book on *The Extra-Ocular Muscles*[2] to his students and explains in the preface that it is an amplification of his lectures given in the Graduate School of Medicine of the University of Pennsylvania. Certain other useful ophthalmological monographs have originated in a similar manner.

After a critical survey of this work, one realizes that the author has succeeded admirably in his endeavor "to crystallize, and at the same time simplify, accepted facts" in this perennially difficult and complex chapter of ophthalmic science. The subtitle, "A Clinical Study of Normal and Abnormal Ocular Motility," is a good designation of the scope of the book. Such a title as "The Extrinsic Ocular Muscles" rather than "The Extra-Ocular Muscles" might prove to be more acceptable choice of terms.

The author's ripe judgment on many controversial points regarding the evaluation of certain orthoptic and also surgical measures adds greatly to the interest and value of the treatise.

W. F. Moncreiff.

MACAUSLAND'S *Poliomyelitis* is an excellent and useful compendium[3] of all that is known about infantile paralysis and is presented in a concise and interesting form. The history of past epidemics and the probable mode of communication is up to date. The methods of treatment in the various stages of the disease are clearly given in detail. The results of the various forms of mechanical, educational, and operative treatment as observed in the author's extensive experience are given without bias, and are presented with the judgment of a careful and conservative orthopedic surgeon.

This book can be recommended to all physicians who are interested in the problems connected with anterior poliomyelitis. Edwin W. Ryerson.

PROFESSOR HENRY has given us exact directions for the best exposure of the humerus, radius, femur, and ulna in his *Exposures of Long Bones and other Surgical Methods*.[4] His anterior method of approach to the femur instead of the customary lateral exposure is of particular interest. He describes it as "respecting anatomy, as being relatively bloodless, and as giving a wide and convenient exposure." The illustrations make the method admirably clear.

In the latter section of the book the author describes exposure of the plantar structures, a method of ligating the second stage of the vertebral artery, a method of ligating the first stage of the left subclavian artery from behind, the "cup and ball" aneurism needle for deep ligations, a new method of resecting the left cervicodorsal ganglion of the sympathetic, and an ingenious instrument for pituitary surgery which is "aimed" at the pituitary by the X-ray.

[1] Gynæcology; for Students and Practitioners. By Thomas Watts Eden, M.D., C.M. (Edin.), F.R.C.P. (Lond.), F.R.C.S. (Edin.), and Cuthbert Lockyer, M.D., B.S., F.R.C.S., F.R.C.P. 3d ed. New York: The Macmillan Company, 1928.

[2] The Extra-Ocular Muscles; a Clinical Study of Normal and Abnormal Ocular Motility. By Luther C. Peter, A.M., M.D., Sc.D. Philadelphia: Lea & Febiger, 1927.

[3] Poliomyelitis; with Especial Reference to the Treatment. By W. Russell MacAusland. Philadelphia: Lea & Febiger, 1927.

[4] Exposures of Long Bones and Other Surgical Methods. By Arnold K. Henry, M.B., B.Ch. (Univ. Dublin), F.R.C.S.I. Foreword by Sir W. I. deC. Wheeler (Dublin). New York: William Wood & Company, 1927.

In the words of Sir W. I. deC. Wheeler in the foreword of the book, the author has provided a valuable contribution to the reference library of the scientific surgeon. FREDERICK CHRISTOPHER.

STERLING V. MEAN has written a voluminous book[1] on diseases of the mouth, consisting of 560 pages, containing about 300 illustrations. It is a very complete work in that nearly every lesion and malformation occurring in the mouth is given consideration. The arrangement is very formal, synonyms and definitions being given before the discussion of the etiology, symptoms, diagnosis, and treatment of each case. For some purposes this is an admirable arrangement, but for the student who wishes a complete knowledge of a specific mouth condition, the text hardly fulfills the requirements. There is much repetition and some of the more important phases are slighted, especially a clear discussion of treatment.

The views expressed are generally sound and logical, however, and the illustrations are beautifully prepared and nicely supplement the text. An extensive bibliography accompanies each chapter and credit is properly given for all material used. Altogether, the book has been painstakingly prepared and should be a valuable addition to the library of the physician as well as the dentist.

CHARLES W. FREEMAN.

IN the preface to his short history of surgery,[2] Dr. von Brunn calls attention to the paucity of books on the historical aspect of surgery apart from general medicine. He says further that the volumes devoted to surgical history alone are exhaustive treatises designed rather for the specialist in history than for the active clinical surgeon. This condition of affairs has prompted him to produce this work, which is designed to cover the major points in the development of surgery from prehistoric to modern times. The author has done his work well and has accomplished his purpose. Written in not too involved German and with illustrations well chosen, the book gives an excellent survey of the subject without going into too much detail. It will prove a welcomed addition to the library of the clinical surgeon interested in the history of his art.

ALFRED BROWN.

COPE in his book[3] has presented a convincing exposition of the value of clinical research. The originality of his methods and the weight of his conclusions are stimulating and profitable to the reader.

The author has made a careful study of the function of the parietal peritoneum and of muscular rigidity. He finds that irritation of the non-demonstrative area of the peritoneum does not lead to rigidity, and points out that rigidity of the abdominal wall is not an essential sign of appendicitis.

The chapter on cutaneous hyperæsthesia in acute abdominal disease is very interesting. The author found hyperæsthesia of greater or less extent in 59 per cent of 185 cases of acute appendicitis. He feels that this symptom can almost always be taken as signifying inflammation or irritation of a viscus or of some part of the peritoneum.

The study of phrenic shoulder pain reaches a conclusion somewhat at variance to that of Capps, namely: "There is an important localizing correspondence between the part of the diaphragm irritated and the position of the referred pain on the shoulder. . . ." Irritation of the anterior part of the diaphragm causes pain in the corresponding clavicular or supraclavicular regions; irritation of the posterior part of the diaphragm causes pain in the supraspinous fossa of the same side; irritation of the top of the phrenic dome causes pain in the corresponding acromioclavicular regions; and, finally, pain felt over both shoulders indicates a median diaphragmatic irritation.

The differential diagnosis between acute thoracic and acute abdominal lesions is handled most interestingly. A chapter is devoted to the genitourinary symptoms in acute appendicitis. The "femoral test for hypogastric peritonitis" should prove of value. The sections devoted to "subacute perinephritic abscess occurring without disease of the kidney" and to the extremely interesting subject of extravasation of bile are based upon abundant experience and greatly enhance the merit of the book. The final chapter is a critical examination of the subject of shock and collapse. This small but extremely valuable book should be in the library of every surgeon. FREDERICK CHRISTOPHER.

THE translation into English of the fifth edition of Professor Hajek's classical work on the nasal accessory sinuses[4] is sure to receive a warm welcome. The publishers are to be congratulated on giving us a more easily handled and attractive work by issuing the translation in two parts instead of one as in the original. The printing is clear and the reproduction of the illustrations leaves little to be desired.

The introductory chapters on the anatomy of the sinuses have numerous well chosen plates illustrating the important variations. The descriptions are clear and concise and one notes with approval that the author emphasizes that no plates, no matter how good, can take the place of frontal and sagittal sections of the head. The various sinuses are fully described. The final chapters deal with the complications involving the orbit and visual organs and cerebral complications. The anatomical variations in the sinuses lead the author to the differential

[1] DISEASES OF THE MOUTH. By Sterling V. Mead, D.D.S. St. Louis: The C. V. Mosby Company, 1927.

[2] KURZE GESCHICHTE DER CHIRURGIE. By W. von Brunn. Berlin: Julius Springer, 1928.

[3] CLINICAL RESEARCHES IN ACUTE ABDOMINAL DISEASE. By Zachary Cope, B.A., M.D., M.S. (Lond.), F.R.C.S. (Eng.). 2d ed. New York and London: Oxford University Press, 1927.

[4] PATHOLOGY AND TREATMENT OF THE INFLAMMATORY DISEASES OF THE NASAL ACCESSORY SINUSES. By Professor Dr. M. Hajek; translated by Joseph D. Heitger, A.B., M.D., and French K. Hansel, M.D., M.S. vols. i and ii. 5th ed. St. Louis: The C. V. Mosby Company, 1926.

diagnosis in diseased conditions and the surgical technique which may best be employed. The chapter on symptoms is especially valuable. Here the author has utilized his great clinical experiences extending over so many years. The abundance of the material at his disposal affords ample opportunity to select appropriate cases. There are numerous footnotes of value with brief review of recent literature, and a valuable bibliography.

The paragraphs on headaches in sinus trouble is characteristically conservative. While not inclined to make the assertion that all cases of nervous and habitual headaches are of nasal origin, he believes that no headache should be accepted as "nervous" until a detailed examination of the nose and sinuses has been made. In the chapter dealing with the etiology and pathological anatomy of the maxillary antrum, the paragraphs dealing with the relation of the teeth to disease in the antrum, is well worthy of note by members of the dental profession.

The translation has been well done and the English speaking specialist will be glad to have so authoritative a work at his disposal.

J. Gordon Wilson.

A TWO volume work[1] on X-ray diagnosis of the stomach and duodenum under the supervision of Duval and other French authors, each of whom is a leader of the specialties of medicine, surgery, and roentgenology is a valuable addition to X-ray bibliography. To the physician who is engaged in X-ray investigations of the digestive tract these books will have an especial appeal. The various lesions that are demonstrable by X-ray shadows are given in half tone illustration accompanied by a line diagram and a detailed description—a particularly commendable feature because of the nature of X-ray evidence in the daily problems of medical and surgical diagnosis. Splendid X-ray illustrations and lucid descriptions make one wish that an English translation were available for those whose linguistic attainments do not include the French language. Many of the various pathological conditions which occur in the stomach and duodenum are presented in logical divisions. E. S. Blaine.

WHILE the title *Minor Surgery*[2] suggests such subjects as paronychia, ingrown toenail, furuncle, and the like, the contents of Hertzler's text cover a materially broader scope than we have found in any similar book previously encountered.

The first two chapters deal with surgical material, sutures, ligatures, dressings, bandaging, etc. Chapters on hæmorrhage and transfusion and infections follow. The chapters on diseases of the lips, tongue, jaws, diseases and injuries of the face and neck, are excellently done. The more common conditions of chest and abdominal wall are presented. Then follow chapters on the spine, anal region, and genitalia. The remainder of the book is devoted to the surgery of the extremities, including such lesions as burns, sprains, infections of tendon sheaths and bursæ. It is quite unusual to see in one book so wide a variety of subjects, ranging from bandaging through numerous special fields of surgery, urology, and gynecology, so well presented and so excellently illustrated. For the student in the out-patient clinic and the interne this is a very valuable book.

J. R. Buchbinder.

WHEN one considers the tremendous task involved in presenting with appropriate illustrations the entire subject of surgery under one cover in a volume of a thousand pages or so, the reviewer should be more tempted to commend the good points of the text than partially to criticize the bad; for it is generally agreed that we can neither learn nor teach surgery from a text.

Ashhurst's book[3] is rather different from most texts on surgery. In the first section, under the heading of "General Surgery" is included inflammation, surgical infections, tumors, injuries, amputations, and re-constructive surgery. The second section designated "Systemic Surgery," covers the vascular and lymphatic systems, bones, joints, and orthopedic surgery. In the third section, devoted to "Regional Surgery," head, neck, chest, and so on down through abdominal surgery and genitalia are covered.

The subject matter is well abreast of current advances in diagnosis and treatment. It is written in excellent English and is both easy and pleasant to read. The illustrations are well chosen and well done. In general this is as satisfactory a book for students of surgery as one could want.

J. R. Buchbinder.

IN the fourth edition of *The Art of Anæsthesia*[4] Flagg has endeavored to bring the volume abreast of the day. The drugs used and the different methods employed for both local and general anæsthesia at the present time are set forth in an organized, logical form. This makes the subject clear even to the beginner in anæsthesia. Some views are expressed in regard to the open drop method of etherization that cannot be subscribed to by many anæsthetists of wide experience. The reviewer is forced to the conclusion that the author has been unfortunate in witnessing the method improperly employed.

The chapter on ethylene is incomplete in that no method of grounding to prevent electrostatic sparks from producing explosions is described. The statement that ethylene is not safe for operative obstetrics is contrary to the experience of many competent observers.

[1] Radiologie Clinique du Tube Digestif. Edited by Pierre Duval, J. Ch. Roux, Henri Béclère. 2 vols. Paris: Masson et Cie, 1927.

[2] Minor Surgery. By Arthur E. Hertzler, M.D., F.A.C.S., and Victor E. Chesky, A.B., M.D., F.A.C.S. St. Louis: The C. V. Mosby Company, 1927.

[3] Surgery, its Principles and Practice; for Students and Practitioners. By Astley P. C. Ashhurst, A.B., M.D., F.A.C.S. 3d ed., thoroughly rev. Philadelphia: Lea & Febiger, 1927.

[4] The Art of Anæsthesia. By Paluel J. Flagg, M.D. 4th ed., rev. Philadelphia and London: J. B. Lippincott Company, 1928.

The great importance of the position of the patient during anæsthesia and the different causes of obstructed breathing are recognized, and means for their correction are fully worth reading, especially by the inexperienced administrator of anæsthetics.

The chapter on "The Point of View of the Patient" is well worth the space given to it. To the lack of appreciation of the patient's point of view is due much of the unintentional cruelty too often exhibited in this day of high pressure and hospital routine carried to extremes. The author very correctly states: "In adopting the patient's point of view, we eliminate much pain and distress. A moment of thoughtfulness is all that is required. A word, a smile, or a sympathetic glance, will do much to lighten anxiety and pain" before operation.

This book will be of value to the medical student, interne, and general practitioner and will be read with interest by the specialist in anæsthetics.

ISABELLA C. HERB.

ALTHOUGH this book of Alvarez on the mechanics of the digestive tract[1] is termed a second edition, it is actually a new book when compared to the first edition. The author discusses thoroughly the mechanical phenomena of the digestive tract from a biological and clinical standpoint in a clear, simple, scientific, and interesting manner. Explanations are offered for many of the symptoms observed in gastro-intestinal disease to an extent that can be found in no other book. Many of the phenomena are interpreted from the viewpoint of the author's metabolic gradient theory which he fully recognizes is only tentative at the present time. The book includes an excellent bibliography of 900 titles and frequently, at the end of a discussion, the reader is referred to monographs which deal in more detail with the subject discussed. The book is not only a valuable contribution to the science of gastro-enterology, but will be of great value to the student of physiology, the internist and surgeon.

A. C. IVY.

PEDIATRICIANS deserve great credit for having called attention to the fact that in illness the child must not be regarded as "a little adult"; that not only do the pathological pictures differ but that the reaction of the child to pathological changes is often entirely different from the reaction of the adult. The same is true in the so-called surgical diseases. Not only do certain conditions such as acute intussusception or idiopathic hypertrophic pyloric stenosis arise in the child which are not seen in the adult, but certain other conditions such as acute appendicitis often show a different symptom complex and run an entirely different course.

In his book on the *Abdominal Surgery of Children*[2] Barrington-Ward has emphasized the characteristic features in the etiology, symptomatology, and treatment of the surgical conditions of infancy and childhood. He has confined his work to the diseases of the abdomen. In a short, well illustrated, clearly written little book, he has presented the salient features. The book is recommended to those surgeons who do not have the opportunity of observing a large amount of the surgery of children, and who will find in this book much that is useful and helpful. Those surgeons who do have a large amount of clinical material among children will find in this book much that is of interest.

RALIH B. BETTMAN.

[1] THE MECHANICS OF THE DIGESTIVE TRACT; AN INTRODUCTION TO GASTRO-ENTEROLOGY. By Walter C. Alvarez, M.D. 2d ed. New York: Paul B. Hoeber, 1928.

[2] THE ABDOMINAL SURGERY OF CHILDREN. By L. E. Barrington-Ward, Ch.M., F.R.C.S. (Edin.), F.R.C.S. (Eng.). New York and London: Oxford University Press, 1928.

BOOKS RECEIVED

Books received are acknowledged in this department, and such acknowledgment must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers and as space permits.

TRAVAUX DE CHIRURGIE. SEPTIÈME SÉRIE. CHIRURGIE DE L'ESTOMAC ET DU DUODÉNOM. By Henri Hartmann. Paris: Masson et Cie, 1928.

L'EXPLORATION RADIOLOGIQUE EN GYNÉCOLOGIE. TECHNIQUE—RÉSULTATS. By Claude Béclère. Preface by Dr. R. Grégoire. Paris: Masson et Cie, 1928.

SALPINGITIS ISTHMICA NODOSA UND DIE POSTTUBERKULOESEN ADNEXVERAENDERUNGEN. By Dr. Franz Horálek. Prag: F. Topič, 1928.

L'ANESTHÉSIE LOCO-RÉGIONALE EN OTO-RHINO-LARYNGOLOGIE ET EN CHIRURGIE CERVICO-FACIALE. By Georges Portmann and Paul Leduc. Paris: Gaston Doin et Cie, 1928.

FASCIAL GRAFTING IN PRINCIPLE AND PRACTICE; AN ILLUSTRATED MANUAL OF PROCEDURE AND TECHNIQUE. By H. C. Orrin, O.B.E., F.R.C.S. (Edin.) Edinburgh and London: Oliver & Boyd, 1928.

FORENSIC MEDICINE; A TEXT-BOOK FOR STUDENTS AND PRACTITIONERS. By Sydney Smith, M.D., (Edin.), D.P.H. With an introduction by Prof. Harvey Littlejohn, F.R.C.S. (Edin.), F.R.S.E. 2d ed. Philadelphia: P. Blakiston's Son & Company, 1928.

THE SURGICAL OPERATIONS ON PRESIDENT CLEVELAND IN 1893; TOGETHER WITH SIX ADDITIONAL PAPERS OF REMINISCENCES. By William W. Keen, M.D. Philadelphia and London: J. B. Lippincott Company, 1928.

CHEMOTHERAPEUTIC RESEARCHES ON CANCER; WITH ESPECIAL REFERENCE TO THE LEAD AND SULPHUR GROUPS. By A. T. Todd, M.B. (Edin.), M.R.C.P.(Lond.), with the help of others. Bristol: J. W. Arrowsmith, Ltd., 1928.

DICTIONARY OF AMERICAN MEDICAL BIOGRAPHY; LIVES OF EMINENT PHYSICIANS OF THE UNITED STATES AND CANADA, FROM THE EARLIEST TIMES. By Howard A. Kelly, M.D., LL.D., and Walter L. Burrage, A.M., M.D. New York and London: D. Appleton & Company, 1928.

GOITER PREVENTION AND THYROID PROTECTION. By Israel Bram, M.D. Philadelphia: F. A. Davis Company, 1928.

HANDBUCH DER UROLOGIE. Edited by A. v. Lichtenberg, F. Voelcker, and H. Wildbolz. Vols. iii and iv.-Spezielle Urologie I and II. Berlin: Julius Springer, 1928.

SURGICAL ANATOMY. By Grant Massie, M.B., M.S. (Lond.), F.R.C.S. (Eng.). Philadelphia: Lea & Febiger, 1928.

DISEASES OF THE GALL BLADDER AND BILE DUCTS; A BOOK FOR PRACTITIONERS AND STUDENTS. By Evarts Ambrose Graham, A.B., M.D., Warren Henry Cole, B.S., M.D., Glover H. Copher, A.B., M.D., and Sherwood Moore, M.D. Philadelphia: Lea & Febiger, 1928.

OBSTETRICAL NURSING; A TEXT-BOOK OF THE NURSING CARE OF THE EXPECTANT MOTHER, THE WOMAN IN LABOR, THE YOUNG MOTHER AND HER BABY. By Carolyn Conant Van Blarcom, R.N. With foreword by J. Whitridge Williams, M.D. 2d ed. rev. New York: The Macmillan Company, 1928.

ESSAYS ON OBSTETRIC SUBJECTS. By the Class of 1928, School of Medicine, University of Pennsylvania.

BLOOD AND URINE CHEMISTRY. By R. B. H. Gradwohl, M.D. and Ida E. Gradwohl, A.B. St. Louis: The C. V. Mosby Company, 1928.

LECTURES OF THE SAN DIEGO ACADEMY OF MEDICINE, SERIES OF 1927: RECENT ADVANCES IN CHEMISTRY IN RELATION TO MEDICAL PRACTICE. By W. McKim Marriott, B.S., M.D. St. Louis: The C. V. Mosby Company, 1928.

CLINICAL CONGRESS OF AMERICAN COLLEGE OF SURGEONS

GEORGE D. STEWART, New York, *President* FRANKLIN H. MARTIN, Chicago, *Director-General*

BOSTON COMMITTEE ON ARRANGEMENTS

FREDERIC J. COTTON, *Chairman* CHARLES G. MIXTER, *Secretary*

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F. W. DUCKERING
A. W. DUDLEY
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JOEL E. GOLDTHWAIT
WILLIAM P. GRAVES
ROBERT B. GREENOUGH
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FRANK H. LAHEY
HALSEY B. LODER
FRED B. LUND
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WILLIAM C. QUINBY
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A. WARREN STEARNS
JAMES S. STONE
LORING T. SWAIM
HAROLD WALKER
WYMAN WHITTEMORE
HANS ZINSSER

PRELIMINARY PROGRAM FOR BOSTON CLINICAL CONGRESS

BOSTON PROGRAM IN BRIEF

Monday, October 8

10:00. Hospital Conference, Ballroom Copley-Plaza Hotel.
2:00. Clinics in the hospitals.
2:00. Hospital Conference, Ballroom Copley-Plaza Hotel.
8:15. Presidential Meeting, Symphony Hall.

Tuesday, October 9

9:00. Clinics in the hospitals.
2:00. Clinics in the hospitals.
8:15. Scientific session, Ballroom Copley-Plaza Hotel.

Wednesday, October 10

9:00. Clinics in the hospitals.
2:00. Clinics in the hospitals.
8:30. Boston Surgical Society, presentation of Bigelow Medal, Ballroom Copley-Plaza Hotel.

Thursday, October 11

9:00. Clinics in the hospitals.
2:00. Clinics in the hospitals.
2:00. Annual Meeting, Ballroom Copley-Plaza Hotel.
3:30. Symposium: Treatment of Malignant Diseases by Radium and X-ray, Copley-Plaza Hotel.
8:15. Scientific session, Ballroom Copley-Plaza Hotel.

Friday, October 12

9:00. Clinics in the hospitals.
2:00. Clinics in the hospitals.
2:30. Symposium on Traumatic Surgery, Ballroom Copley-Plaza Hotel.
8:15. Convocation, Symphony Hall.

FOR the eighteenth annual Clinical Congress of the American College of Surgeons to be held in Boston from Monday, October 8, to Friday, October 12, inclusive, the surgeons of Boston have planned a highly attractive program of clinics and demonstrations. The program is ample and varied, and with increased clinical facilities a record-breaking attendance is expected at this year's meeting.

A preliminary program of the clinics and demonstrations as prepared by the Committee on Arrangements is presented in the following pages. During the weeks preceding the meeting these schedules will be revised and amplified so that the final program will completely represent the clinical activities of that great medical center in all departments of surgery. The real program of the Congress will be issued daily. Each afternoon there will be posted at headquarters, in the form of bulletins, a complete and accurate schedule of the clinics and demonstrations to be given on the succeeding day. Printed programs will be issued each morning.

The subcommittee in charge of the section on surgery of the eye, ear, nose and throat has prepared, in addition to a series of clinics and demonstrations at the hospitals which will occupy the morning hours of each day, a series of clinical demonstrations for Tuesday, Thursday and Fri-

day afternoons to be given in the Georgian Room at the Statler Hotel. A detailed program therefor will be found in the following pages. A special session on Wednesday afternoon will be devoted to a symposium dealing with the standardization of the eye, ear, nose, and throat departments in general hospitals.

General headquarters for the Congress will be established at the Statler Hotel where the ballroom, foyer and other large rooms on the mezzanine floor have been reserved and will be used for registration and ticket bureaus, bulletin boards, technical exhibition, executive offices, etc. The ballroom at the Copley-Plaza will be utilized for evening meetings, hospital conference, annual meeting and other large gatherings.

An important feature of the general program for this year's meeting will be the showing of several surgical films that have been produced under the supervision of and approved by the American College of Surgeons. A number of films are now complete, while others are in course of preparation and will be ready for their premier showing in Boston.

Arrangements have been made for the celebration of "Ether Day" at the Massachusetts General Hospital Friday forenoon. Exercises, beginning at 10 o'clock, will be held in the dome room of the old building of the hospital where ether was first administered for the production of surgical anæsthesia on October 16, 1846. A bronze bust of William T. G. Morton will be presented to the hospital.

The annual meeting of the Fellows of the College will be held on Thursday afternoon in the ballroom of the Copley-Plaza Hotel beginning at 2 P.M. Reports of officers and standing committees will be presented, and officers elected for the ensuing year.

Immediately following the annual meeting there will be presented a symposium dealing with the treatment of malignant diseases with radium and X-ray under the leadership of Dr. Robert B. Greenough, of Boston, Chairman of the Committee on the Treatment of Malignant Diseases. A special report on the treatment of cancer of the breast is to be presented.

Friday afternoon's session in the ballroom of the Copley-Plaza Hotel will be devoted to a symposium on Traumatic Surgery. Leaders in industry, education and labor, together with representatives of indemnity companies and the medical profession will contribute to the discussion. A report will be presented by the Chairman of the Board on Traumatic Surgery as to its activities in the present year. A definite program has been adopted by the Board and put into effect. The results of the investigations made during the year will be presented.

At the Tuesday evening meeting Sir Squire Sprigge, Editor of the London *Lancet*, will deliver the Hunterian oration. A symposium on the transplantation of ureters with papers by Drs. Charles H. Mayo, Robert C. Coffey, Arthur H. Curtis and others, will be a feature of the Tuesday evening meeting.

At a special meeting of the Boston Surgical Society on Wednesday evening, at which the visiting surgeons will be guests of that Society, the Bigelow Medal is to be presented to Professor Chevalier Jackson of Philadelphia.

Sir George A. Syme, of Malvern, Australia, president of the Australasian College of Surgeons, will be a guest at this year's Congress. Other distinguished surgeons from abroad who will attend are Professor Archibald Young and Dr. Farquhar Macrae, of Glasgow, Scotland; Sir John Lynn Thomas, of Llechryd, Wales; and Sir Charles P. B. Clubbe, of Sydney, Australia.

EVENING MEETINGS

Programs for evening sessions on each of the five days of the Congress are being prepared by the executive committee of the Congress. At the Presidential Meeting in Symphony Hall on Monday evening the president-elect, Dr. Franklin H. Martin, of Chicago, will be inaugurated and deliver the annual address. On the same evening Professor Vittorio Putti, professor of orthopedic surgery in the University of Bologna, Italy, and Director of the Rizzoli Institute, will deliver the Murphy Oration on Surgery.

On Tuesday, Wednesday and Thursday evenings the sessions will be held in the ballroom of the Copley-Plaza Hotel. The annual Convocation of the College will be held on Friday evening in Symphony Hall, at which time the 1928 class of candidates for fellowship in the College will be received. The fellowship address on that occasion is to be delivered by Dr. William J. Mayo.

ANNUAL HOSPITAL CONFERENCE

For the eleventh annual Hospital Conference of the American College of Surgeons an interesting series of papers, practical demonstrations and round table conferences that deal with many of the problems relating to hospital efficiency has been prepared and will be found in the following pages. The conference opens at 10 o'clock on Monday morning with a session in the ballroom of the Copley-Plaza Hotel. Morning and afternoon sessions in the same room are planned for

the following days. The program has been arranged especially to interest surgeons, hospital superintendents, trustees, nurses and hospital personnel generally, and a cordial invitation is extended to all persons interested in hospital work to attend.

The session on Wednesday afternoon will be of particular interest to those whose practice is limited to surgery of the eye, ear, nose and throat, being devoted to a discussion of the principles involved in the standardization of such special departments in general hospitals.

SPECIAL TRAIN FROM CHICAGO

For the convenience of Fellows living in the central and western states, who will attend the Boston meeting, arrangements have been made with the New York Central Lines to provide a special train leaving Chicago at 9 A.M. on Sunday, October 7, arriving in Boston at 9 A.M. on Monday. The special train will be equipped with all steel cars of late design, including club, compartment, observation, sleeping and dining cars. No extra fare will be charged. The special will arrive at Cleveland at 5:28 P.M., making connections there with regular trains over the Big Four from Indianapolis and Cincinnati. This arrangement is contingent upon reservations for such a special train being made by the minimum number required by the Interstate Commerce Commission rules. Fellows are urged to make their reservations for the special train at the earliest possible date.

REDUCED RAILWAY FARES

The railways of the United States and Canada have authorized reduced fares on account of the Boston session of the Clinical Congress, so that the total fare for the round trip will be one and one-half the ordinary first-class one-way fare. To take advantage of the reduced rates it is necessary to pay the full one-way fare to Boston, procuring from the ticket agent when purchasing ticket, a "convention certificate" which certificate is to be deposited at headquarters for the visé of a special agent of the railways. Upon presentation of a viséed certificate to the ticket agent in Boston not later than October 16th a ticket for the return journey by the same route as traveled to Boston may be purchased at one-half the regular one-way fare.

In the eastern, central, and southern states and eastern provinces of Canada, tickets may be purchased between October 4th and 10th; in southwestern and western states between October 3d and 9th, and in the far western states and western provinces of Canada between September 30th and October 6th. The return journey from Boston must be begun not later than October 16th.

The reduction in fares does not apply to Pullman fares, nor to excess fares charged for passage on certain trains. Local railroad ticket agents will supply detailed information with regard to rates, routes, etc. Stop-overs on both the going and return journeys may be had within certain limits.

Full fare must be paid from starting point to Boston, and it is essential that a "convention certificate" be obtained from the agent from whom the ticket is purchased. These certificates are to be signed by the general manager of the Clinical Congress and viséed by a special railroad agent in Boston during the meeting. No reduction in railroad fares can be secured except in compliance with the regulations outlined and within the dates specified. It is important to note that the return trip must be made by the same route as that used to Boston and that the certificate must be presented during the meeting and return ticket purchased and used not later than October 16th.

An exception to the above arrangement is to be noted in the case of persons traveling from points in the Pacific Coast states and British Columbia, who will be able to purchase round trip summer excursion tickets which will be on sale up to and including September 30th with a final return limit of October 31st. The summer excursion fare is somewhat lower than the convention fare mentioned above, but is available only in the Pacific Coast states and British Columbia. Tickets sold at summer excursion rates permit traveling to Boston via one direct route and returning via another direct route, with liberal stop-over privileges.

BOSTON HOTELS AND THEIR RATES

Since the last Clinical Congress in Boston in 1922, a number of new hotels have been built, including the Statler with 1300 guest rooms, the New Parker, and the Ritz-Carlton. Some of the older hotels have been enlarged so that there are now ample first-class hotel accommodations in Boston for all who wish to attend the Clinical Congress. Many of these hotels are located within short walking distance of the headquarters hotels.

	Minimum Rates with Bath	
	Single Room	Double Room
Bellevue, 21 Beacon St.	$4.00	$7.00
Braemore, 464 Commonwealth Ave.	4.00	7.00
Brunswick, Boylston and Clarendon Sts.	3.50	5.00
Buckminster, 645 Beacon St.	3.00	4.00
Canterbury, 14 Charlesgate West.	4.00	5.00
Charlesgate, Charlesgate East.	3.00	5.00

	Minimum Rates with Bath	
	Single Room	Double Room
Copley Plaza, Copley Square	$4.00	$7.50
Elks, 275 Tremont St	3.50	5.00
Fensgate, 534 Beacon St	4.00	5.00
Gralyn, 20 Charlesgate West	3.00	5.00
Kenmore, 496 Commonwealth Ave	3.50	6.00
Lenox, Exeter and Boylston Sts	3.50	4.50
Lincolnshire, 20 Charles St	4.00	6.00
New Parker, Tremont and School Sts	3.50	5.50
Puritan, 390 Commonwealth Ave	3.50	5.00
Ritz-Carlton, Arlington and Newbury Sts	5.00	8.00
Sheraton, 91 Bay State Road	5.00	6.00
Somerset, 400 Commonwealth Ave	3.00	5.00
Statler, Park Square at Arlington St	3.50	5.50
Touraine, Boylston and Tremont Sts	5.00	7.50
Vendome,* Commonwealth and Dartmouth	8.00	16.00
Victoria, Dartmouth and Commonwealth	4.00	6.00
Westminster, Copley Square	3.00	5.00

*American plan.

LIMITED ATTENDANCE—ADVANCE REGISTRATION

Attendance at the Boston session will be limited to a number that can be comfortably accommodated at the clinics, the limit of attendance being based upon the result of a survey of the amphitheaters, operating rooms, and laboratories in the hospitals and medical schools as to their capacity for accommodating visitors. Under this plan it will be necessary for those who wish to attend to register in advance.

Attendance at clinics and demonstrations will be controlled by means of special clinic tickets, which plan has proved an efficient means of providing for the distribution of visiting surgeons among the several clinics and insures against overcrowding, the number of tickets issued for any clinic being limited to the capacity of the room assigned to that clinic.

REGISTRATION FEE

A registration fee of $5.00 is required of each surgeon attending the annual Clinical Congress, such fee providing the funds with which to meet the expenses of the meeting. To each surgeon registering in advance a formal receipt for the registration fee is issued, which receipt is to be exchanged for a general admission card upon his registration at headquarters. This card, which is nontransferable, must be presented to secure clinic tickets and admission to the evening meetings.

PRELIMINARY PROGRAM FOR EVENING MEETINGS

Presidential Meeting, Monday, October 8—Symphony Hall, 8:15 P.M.

Address of Welcome: FREDERIC J. COTTON, M.D., Boston, Chairman of Committee on Arrangements.

Address of Retiring President: GEORGE DAVID STEWART, M.D., New York.

Introduction of Foreign Guests.

Inaugural Address: FRANKLIN H. MARTIN, M.D., Chicago.

The John B. Murphy Oration in Surgery: Malignant Bone Tumors. PROFESSOR VITTORIO PUTTI, Bologna, Italy.

Tuesday, October 9—Ballroom, Copley-Plaza Hotel, 8:15 P.M.

Hunterian Oration: SIR SQUIRE SPRIGGE, M.D., B.Ch., F.R.C.S., London.

Symposium: Ureteral Transplantation.

ROBERT C. COFFEY, M.D., Portland, Oregon: Transplantation of Ureters into the Large Bowel.

ARTHUR H. CURTIS, M.D., Chicago.

CHARLES H. MAYO, M.D., Rochester, Minn.: Contributing Causes of Genito-Urinary Anomalies.

Discussion: GEORGE GILBERT SMITH, M.D., and WILLIAM CARTER QUINBY, M.D., Boston.

Wednesday, October 10—Ballroom, Copley-Plaza Hotel, 8:30 P.M.

Special Meeting of the Boston Surgical Society: The Presentation of the Henry J. Bigelow Medal to CHEVALIER JACKSON, M.D., Philadelphia.

Thursday, October 11—Ballroom, Copley-Plaza Hotel, 8:15 P.M.

PROFESSOR ARCHIBALD YOUNG, M.B., C.M., F.R.F.P.S., Glasgow: Sacro-Coccygeal Chordoma.

GEORGE W. HOLMES, M.D., Boston: Results of X-ray Treatment in Cases of Cancer of the Breast.

SIR CHARLES BALLANCE, K.C.M.G., C.B., M.V.O., London: The International Cancer Conference, British Empire Cancer Campaign.

GEORGE W. CRILE, M.D., Cleveland: The Adrenal Factor in Hyperthyroidism.

COLONEL SIR JOHN LYNN-THOMAS, K.B.E., C.M.G., C.B., F.R.C.S., Llechryd, Wales: Motion pictures on orthopedic subjects, with introductory remarks.

Convocation, Friday, October 12—Symphony Hall, 8:15 PM.

Conferring of Honorary Fellowships.

Presentation of Candidates for Fellowship.

Presidential Address: FRANKLIN H. MARTIN, M.D., Chicago.

Fellowship Address: WILLIAM J. MAYO, M.D., Rochester, Minn.

PRELIMINARY CLINICAL PROGRAM

GENERAL SURGERY, GYNECOLOGY, OBSTETRICS, UROLOGY, ORTHOPEDICS

MASSACHUSETTS GENERAL HOSPITAL

Monday

Orthopedic Staff—2. Dry clinics.
NATHANIEL ALLISON. Tuberculosis of the knee.
P. D. WILSON. Tuberculosis of the spine.
N. M. SMITH-PETERSEN. Tuberculosis of the sacro-iliac.
R. K. GHORMLEY. Internal derangements of the knee.
NATHANIEL ALLISON and ARMIN KLEIN. Congenital dislocation of the hip.
J. H. MEANS, E. P. RICHARDSON and GEORGE HOLMES—2. Thyroid clinic.
MONROE MCIVER—3. Observations of burns.
P. D. WHITE and HOWARD SPRAGUE—3:30. The heart in surgery.
G. A. LELAND—4. Fascial repair of hernia.
Surgical laboratories open from 2 to 4.

Tuesday

J. D. BARNEY, R. F. O'NEILL, G. G. SMITH, H. H. CRABTREE and F. H. COLBY—9. Genito-urinary clinic, operations and demonstration of cases.
Surgical Staff—11. General surgical operations and demonstration of cases.
W. J. MIXTER, J. B. AYER and J. S. HODGSON—2. Surgery of the nervous system, operations and demonstrations.
D. F. JONES—2. Cancer of the colon and rectum.
L. B. MCKITTRICK—3. Spinal anæsthesia.
C. A. PORTER—3:30. X-ray burns.
J. V. MEIGS—4. Uterine bleeding.
A. W. ALLEN and R. SMITHWICK—4:30. Circulatory diseases of the extremities.
Staff—2. Demonstrations in surgical research laboratories.
DRS. YOUNG, MALLORY and HARTWELL—3. "Cabot Clinic" (pathology).

Wednesday

Surgical Staff—9. General surgical operations.
DR. KAZANJIAN—12. Plastic surgery.
WYMAN WHITTEMORE and DR. LORD—2. Thoracic surgery, operations and demonstration of cases.
R. C. CABOT and MISS CANNON—2. Social service.
H. D. LLOYD and associates—3. Syphilis in surgery.
T. W. HARMER—3:30. Tendon and nerve sutures.
WILLIAM HERMAN—4:15. Psychiatry and surgery.
Surgical laboratories open for inspection from 2 to 4.

Thursday

Orthopedic Service—9. Operations and demonstration of cases.
P. D. WILSON and MURRAY DANFORTH. Arthritis of the spine.
NATHANIEL ALLISON and KENNETH COONSE. Arthritis of the knee.
W. ROGERS and W. A. STRAMMER. Arthritis of the hip.
R. K. GHORMLEY and HARRY LOW. Poliomyelitis.
WILLIAM A. ROGERS. End-result studies.
Fracture Service—2. Demonstration of cases.
B. VINCENT—2. Surgery of the spleen.
E. P. RICHARDSON—2:30. Hernia through the cardiac orifice of the diaphragm.
Staff—2. Demonstrations in surgical research laboratories.
L. DAVIS—3. Cancer of the cæcum; the duodenum and common bile duct.
J. M. HANFORD (Presbyterian Hospital, New York), R. H. MILLER and W. M. SHEDDEN—2:30. Surgical tuberculosis; cervical adenitis.
E. M. DALAND—4:30. Plastic surgery.

Friday

"Ether Day Celebration"—10. Presentation of bust of Dr. W. T. G. Morton by the Associated Anæsthetists of the United States and Canada and the International Research Society.
ROBERT H. GREENOUGH, C. C. SIMMONS and associates—2. Tumor clinic.
GEORGE HOLMES and associates—3. X-ray and surgery.

HUNTINGTON MEMORIAL HOSPITAL

Wednesday—2, Dry clinics

E. M. DALAND and G. W. TAYLOR. Carcinoma of the skin.
C. C. SIMMONS and C. C. LUND. Cancer of the tongue and buccal mucosa.
G. A. LELAND and J. V. MEIGS. Carcinoma of the cervix.
R. B. GREENOUGH and C. C. SIMMONS. Varying degrees of malignancy in cancer.
WILLIAM M. SHEDDON and E. P. HAYDEN. Cancer of the rectum.
E. M. HERMAN and H. V. KAZANJIAN. Cancer of the antrum and accessory sinuses.

Thursday—2, Dry clinics

W. DUANE and J. C. HUDSON. The modern X-ray plant.
E. M. DALAND and W. M. SHEDDON. Cancer of the lip.
G. G. SMITH. Carcinoma of the genito-urinary tract.
R. B. GREENOUGH and C. C. SIMMONS. Carcinoma of the breast.
C. C. SIMMONS. Malignant bone tumors.
E. M. DALAND and C. C. LUND. Electrocoagulation in the treatment of malignant disease.

NEW ENGLAND DEACONESS HOSPITAL

D. F. JONES and LELAND MCKITTRICK—9, daily. General surgical clinic, operations and demonstration of cases.
F. H. LAHEY, H. M. CLUTE, R. L. MASON and L. F. SISE—9, daily. General surgical clinic, spinal anæsthesia, thyroid cases, operations and demonstration of cases.
D. F. JONES and LELAND MCKITTRICK—2, daily. Dry clinic: Cancer of the large intestine; surgery of diabetics.
E. P. JOSLIN, F. G. BRIGHAM, H. F. ROOT, PRISCILLA WHITE and W. STANLEY CURTIS—2:30, daily. Treatment of the surgical diabetic; diabetes and hyperthyroidism.
F. H. LAHEY, H. M. CLUTE and R. L. MASON—3, daily. Dry clinic: Œsophageal diverticulum; heart failure and hyperthyroidism; cancer of the thyroid; fascial sutures in hernia repair; thyroid crises.
SARA M. JORDAN—3:40, daily. Indications for surgery in peptic ulcer.
L. M. HURXTHAL—3:50, daily. Cardiac conditions complicating surgery.
L. B. MORRISON—4, daily. X-ray demonstrations, diagnosis and therapeusis.

PETER BENT BRIGHAM HOSPITAL

Monday

HARVEY CUSHING—2:30. Neurosurgical clinic.
FRANCIS NEWTON—3:30. Diverticulitis.
CHANNING FROTHINGHAM—4. Passing of the chronic appendix.
E. S. EMERY, JR.—4:30. Study of the results of medical and surgical treatment of peptic ulcer.

Tuesday

Staff—9:30. Surgical operations.
H. A. CHRISTIAN—2:30. Medical diagnostic and therapeutic clinic.
GILBERT HORRAX—3:30. Cordotomy for the relief of pain.
J. P. O'HARE—4. Hypertension and nephritis in relation to surgery.
DAVID CHEEVER—4:30. Surgical diagnostic clinic.

Wednesday

Staff—9:30. Surgical operations.
M. C. SOSMAN—2:30. X-ray study of massive atelectasis of the lung.
G. P. GRABFIELD—3. Effect of drugs on the nitrogen metabolism.
JOHN HOMANS—3:30. Treatment of varicose ulcer.
S. A. LEVINE—4. Heart disease in surgery.
S. B. WOLBACH—4:30. Demonstration in surgical pathology.

Thursday

Staff—9:30. Surgical operations.
W. C. QUINBY—2:30. Surgical clinic.
R. H. FITZ—3. Insulin in surgical conditions.
WILLIAM MURPHY and JOHN POWERS—3:30. Treatment of secondary anæmia by liver diet.
HARVEY CUSHING and TRACY PUTNAM—4. Pituitary gland and its influence on growth.

CHILDREN'S HOSPITAL

Monday

R. B. OSGOOD, W. E. LADD and associates—2. Fracture conference, combined surgical and orthopedic services.

Tuesday

Surgical staff—9. General surgical operations followed by dry clinic.
WILLIAM E. LADD. Hare lip and cleft palate.
C. G. MIXTER. Contractures and plastics.
H. W. HUDSON. Angiomata.
G. D. CUTLER and KENNETH BLACKFAN. Medical aspects of empyema and lung abscess.
Orthopedic staff—2. Dry clinic, infantile paralysis.
W. L. AYCOCK and E. H. LUTHER Epidemiology, occurrence, serum treatment.
S. M. FITCHET. Demonstration of apparatus for prevention of deformity in early cases
MISS MERRILL. Muscle training.
FRANK OBER. Tendon transplantation.
E. W. RYERSON (Chicago) and A. T. LEGG. Stabilizing operations.
A. T. LEGG. Operations.
FRANK OBER. Moving pictures.

Wednesday

W. E. LADD, R. B. OSGOOD and associates—9. Combined clinic of surgical and orthopedic services, present policies in the treatment of glandular, intra-abdominal, bone, and joint tuberculosis.
R. B. OSGOOD, W. E. LADD and associates—2. Combined clinic of surgical and orthopedic services, osteomyelitis, acute, chronic, circumscribed; Brodie's abscess; septic joints; types of infection and treatment.

Thursday

Orthopedic staff—9. Dry clinic.
ALFRED TAYLOR (New York) and J. W. SEVER. Conference on obstetrical paralysis with lantern slides and moving pictures.
FREEMAN ALLEN, F. SMITH (New York), W. B. CANNON and A. H. BREWSTER. Conference on spastic palsy.
BRONSON CROTHERS and MISS TRAINOR. Muscle training.
A. H. BREWSTER. Stoeffel operation.
Surgical staff—2. General surgical operations followed by dry clinic.
C. G. MIXTER. Urinary obstruction and infection.
W. E. LADD. Kidney stone.
THOMAS LANMAN. Hernia and undescended testicle.
C. G. MIXTER and S. B. WOLBACH. Kidney tumors, pathological aspects.

Friday

Surgical staff—9. General surgical operations followed by dry clinic.
WILLIAM E. LADD. Pyloric stenosis.
G. D. CUTLER. Idiopathic peritonitis.
AUGUSTUS THORNDIKE. Appendicitis.
C. G. MIXTER. Intussusception.
WILLIAM E. LADD. Obliteration of bile ducts.
Orthopedic staff—2. Dry clinic.
ELLIOTT G. BRACKETT (Cincinnati) and H. J. FITZSIMMON. Conference on torticollis followed by operation.
F. D. DICKSON (Kansas City) and R. SOUTTER. Conference on congenital dislocation of hip followed by closed reduction and shelf operation.

FREE HOSPITAL FOR WOMEN

Monday

W. P. GRAVES and DR. SMITH—2. Dry clinic: Gynecological pathology, demonstration of specimens and slides.

Tuesday

W. P. GRAVES, FRANK A. PEMBERTON and R. G. WADSWORTH—9. Gynecological operations: Amputation of cervix and cœliotomy (first stage procidentia); perineorrhaphy (second stage procidentia); hysterectomy for fibroid; dilatation and curettage, cœliotomy for retroversion.

Wednesday

W. P. GRAVES, FRANK A. PEMBERTON and E. B. SHEEHAN—9. Gynecological operations: Plastic and cœliotomy (reconstruction operation); hysterectomy for fibroid; dilatation and curettage, cœliotomy for retroversion; perineorrhaphy for complete laceration of perineum.

Thursday

W. P. GRAVES, FRANK A. PEMBERTON and DR. SMITH—9. Gynecological operations: Amputation of cervix and cœliotomy for procidentia; plastic and cœliotomy for prolapse (reconstruction operation); hysterectomy for fibroid; closure of vesicovaginal fistula.

Friday

W. P. GRAVES, FRANK A. PEMBERTON and DR. SMITH—9. Gynecological operations: Hysterectomy for cancer; dilatation and curettage and application of radium for cancer. Dry clinic: Demonstration of cancer cases treated.

BOSTON CITY HOSPITAL

Monday

N. R. Mason, R. M. Green, G. T. Williams, F. L. Good, J. P. Cohen, H. V. Hyde and F. J. Lynch—2. Gynecological and obstetrical clinic, operations and demonstration of cases.

Tuesday

H. Binney, A. R. Kimpton, H. H. Howard, G. W Papen, D. D. Scannell, S. Fraser, J. J. Hepburn and T. W. Wickham—9. Surgical clinic, operations and demonstration of cases.

Surgical Services I and III—2. Dry clinic.

F. W. White—2. Intussusception of the bowel occurring within the stomach following gastro-enterostomy.

G. C. Shattuck—2. Surgical aspects of some tropical maladies.

Wednesday

H. B. Loder, J. J. Walker, F. F. Henderson, E. Harding, J. C. Hubbard, R. C. Cochrane, D. Munro, A. Riley and T. Richards—9. Surgical clinic, operations and demonstration of cases.

Surgical Services II and V—2. Dry clinic.

G. R. Minot and J. T. Wearn—2. Dry clinic.

W. R. Ohler—2. The care of the surgical diabetic.

F. B. Mallory—2. Pathological demonstration.

Thursday

F. J. Cotton, O. J. Herman, J. H. Shortall and W. Morrison—9. Surgical clinic, operations and demonstration of cases.

D. Munro and Tracy Putnam—9. Neurosurgical operations.

Surgical Service IV—2. Dry clinic: Neurosurgical cases.

S. Cobb and A. Myerson—2. Neurological clinic.

B. Butler—2. X-ray demonstration.

Friday

F. B. Mallory, P. F. Butler, F. J. Cotton, R. W. Andrews and others—9. Conferences and presentation of special subjects.

CARNEY HOSPITAL

Monday

A. R. MacAusland—2. Dry clinic: Traumatic injuries of the hip joint, illustrated.

H. G. Lee—2. Dry clinic: Fractures of the femoral shaft and of the table of tibia; wrist joint arthroplasties.

D. F. Mahoney—2. Dry clinic: Radical operations for carcinoma of the breast and perforating duodenal ulcer, with presentation of cases.

Tuesday

F. B. Lund, A. McK. Fraser and associates—9. Surgical operations.

F. W. Johnson, L. E. Phaneuf and associates—9. Gynecological and obstetrical operations.

A. L. Brett—2. Dry clinic: Ununited fracture of neck of femur; bone screws in fractures; fusion of spine.

F. B. Lund, E. J. Denning and W. E. Browne—2. Dry clinic: Chronic duodenal ulcer.

F. W. Johnson—2. Dry clinic: End-results following interposition operation for uterine prolapse (lantern slides).

Wednesday

D. F. Mahoney, W. E. Browne and associates—9. General surgical operations.

F. W. Johnson, L. W. Phaneuf and associates—9. Gynecological and obstetrical operations.

P. N. Jepson—2. Dry clinic: Relative value of various types of operative bone splinting, including the massive bone graft; treatment of chronic arthritis of the spine, operative and nonoperative; incidence, recognition and treatment of spondylolisthesis; over-correction of deformities in fractures.

A. McK. Fraser—2. Dry clinic: Cæcostomy in acute appendicitis with peritonitis, presentation of cases.

L. E. Phaneuf—2. Dry clinic: The low or cervical cæsarean section (lantern slides).

Thursday

F. B. Lund, A. McK. Fraser and associates—9. General surgical operations.

F. W. Johnson, L. F. Phaneuf and associates—9. Gynecological and obstetrical operations.

W. R. MacAusland—2. Dry clinic: Mobilization of the knee and elbow.

M. H. Bloomberg—2. Dry clinic: Scoliosis and club foot.

E. J. Denning—2. Dry clinic: Postoperative medical problems; pre-operative treatment in cardiac cases.

L. E. Phaneuf—2. Dry clinic: Uterine bleeding (lantern slides).

Friday

D. F. Mahoney, W. E. Browne and associates—9. General surgical operations.

F. W. Johnson, L. E. Phaneuf and associates—9. Gynecological and obstetrical operations.

A. Sargent and B. A. Godvin—2. Orthopedic clinic.

E. J. Denning—2. Dry clinic: Intestinal parasites in immigrants.

W. E. Browne—2. Dry clinic: Fractures and injuries of hand and forearm; presentation of special splints.

L. E. Phaneuf—2. Dry clinic: Appendicitis and pregnancy.

NEW ENGLAND BAPTIST HOSPITAL

Tuesday

E. L. Young, Jr., D. L. Jackson, H. B. Loder and D. J. Bristol, Jr.—9. General surgical clinic, operations and demonstration of cases.

Wednesday

F. H. Lahey and H. M. Clute—9. Surgical operations.

Sara M. Jordan and E. Kiefer—2. Gastro-enterological clinic.

Thursday

E. L. Young, Jr., D. L. Jackson, H. B. Loder and D. J. Bristol, Jr.—9. General surgical clinic, operations and demonstration of cases.

BOSTON LYING-IN HOSPITAL

Tuesday

Staff—9. Dry clinics.

B. E. Hamilton. Heart disease in pregnancy.

F. S. Newell. Treatment of pregnancy complicated by heart disease.

S. Berman. End-results in pre-eclamptic toxæmia.

F. C. Irving. Treatment of pre-eclamptic toxæmia by removal of blood plasma and reinfusion of corpuscles.

E. G. Crabtree. Clinical aspects of pyelitis in pregnancy.

G. C. Prather. The postpartum bladder.

Wednesday

Staff—9. Obstetrical operations.

HARVARD MEDICAL SCHOOL

Monday

DRS. GAMBLE and KEEVER—2. Acid base factors in pyloric and duodenal obstruction in children.

DRS. WOLBACH and BLACKFAN—2. Hæmatological studies with special reference to splenectomy in children.

BRONSON CROTHERS—2. Studies of injuries to the spinal cord in infants.

W. L. MOSS and DR. ELEY—2. Studies concerning blood transfusion.

LLOYD D. FELTON—2. Pneumococcus antibody solution, methods and uses.

W. LLOYD AYCOCK and E. H. LUTHER—2. Infantile paralysis: modes of spread, use of convalescent serum, experiments in immunity, and epidemiology of the disease.

M. J. ROSENAU and H. B. ANDERVENT—2. Filterable viruses, experiments on encephalitis, herpes and vaccine virus.

W. B. CANNON—2. Complete denervation of heart; effects of total sympathectomy.

ALEX. FORBES and HALLOWELL DAVIS—2. Demonstration in laboratory, electrical methods for analyzing functions of nerve tissue.

The new electrophysiology center will be open for inspection to any who are interested in the physiology of the nervous system.

Tuesday

DRS. GAMBLE and KEEVER—2. Acid base factors in pyloric and duodenal obstruction in children.

DRS. WOLBACH and BLACKFAN—2. Hæmatological studies with special reference to splenectomy in children.

BRONSON CROTHERS—2. Studies of injuries to the spinal cord in infants.

W. L. MOSS and DR. ELEY—2. Studies concerning blood transfusion.

L. W. SMITH—2. Pathology of the thyroid gland.

C. L. CONNOR—2. The behavior of certain tumors of fowls when transplanted to bone; studies in carotin, its occurrence, its preparation in pure forms, results of injection and feeding experiments.

HENRY PINKERTON—2. The behavior of oils and fats in the lungs; the pathology of the splenomegalies in childhood.

SHIELDS WARREN—2. The prevention of peritoneal adhesions by amniotic fluid, experimental and clinical results.

M. J. SCHLESINGER—2. The effects of hæmatoporphyrin on animals.

DRS. WOLBACH and HOWE—2. The pathology of the deficiency diseases, with special reference to scorbutus, rachitis and vitamin-A deficiency (xerophthalmia).

Wednesday

LLOYD D. FELTON—2. Pneumococcus antibody solution, methods and uses.

W. LLOYD AYCOCK and E. H. LUTHER. Infantile paralysis, modes of spread, the use of convalescent serum, experiments in immunity, and epidemiology of the disease.

J. W. SCHERESCHEWSKY—2. Cancer, the use of high frequency currents.

M. J. ROSENAU and H. B. ANDERVENT. Filterable viruses, experiments on encephalitis, herpes and vaccine virus.

W. B. CANNON—2. Complete denervation of the heart; effects of total sympathectomy.

ALEX. FORBES and HALLOWELL DAVIS. Demonstration in laboratory; electrical methods for analyzing the functions of nerve tissue.

PHILIP DRINKER—2. New methods of artificial respiration.

CECIL K. DRINKER and STEPHEN WENT—2. New colloid solutions for intravenous injections as substitutes for simple salt solutions.

LOUIS A. SHAW—2. Experiments on the exchange of gases through normal tissues.

STANLEY COBB—2. Microscopic demonstration of capillary injection of the brain.

H. S. FORBES—2. Demonstration of the cerebral circulation in living cats.

Thursday

L. W. SMITH—2. Pathology of the thyroid gland.

C. L. CONNOR—2. The behavior of certain tumors of fowls when transplanted to bone; studies on carotin, its occurrence, its preparation in pure form; results of injection and feeding experiments.

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DRS. WOLBACH and HOWE—2. The pathology of the deficiency diseases with special reference to scorbutus, rachitis and vitamin-A deficiency (xerophthalmia).

EDWIN J. COHN—2. The interaction between proteins and electrolytes, or the more special problem concerned with the nature "of the material in liver effective in pernicious anæmia."

STANLEY COBB—2. Microscopic demonstration of capillary injection of the brain.

H. S. FORBES—2. Demonstration of the cerebral circulation in living cats.

Friday

Conferences in general surgery, orthopedics, genito-urinary surgery, gynecology and obstetrics, from 9 to 12.

THORNDIKE MEMORIAL—BOSTON CITY HOSPITAL

Tuesday and Thursday, 2:30

GEORGE R. MINOT. Treatment of pernicious anæmia.

DRS. MINOT, WEARN and others. Epilepsy; capillary circulation; achylia gastrica; anæmia and disorders of the blood; cardiovascular diseases; metabolism; bacteriology.

R. P. STRONG. Demonstration of certain tumors of parasitic origin.

G. C. SHATTUCK. Lecture on tropical diseases of surgical interest.

SURGICAL LABORATORY—MASSACHUSETTS GENERAL HOSPITAL

Tuesday and Thursday, 2

M. A. MCIVER. Experimental problems in connection with intestinal obstruction.

J. C. WHITE. Subject to be announced.

R. H. SMITHWICK. Circulatory disorders of the extremities.

MASSACHUSETTS GENERAL HOSPITAL

Wednesday, 9

A. V. BOCK. Studies on the physiology of muscular work in health and disease.

J. C. AUB. Investigations in calcium metabolism bearing on bone growth and repair.

W. O. THOMPSON. Studies on thyroid disease; iodine dosage in exophthalmic goiter, thyroxin in myxœdema.

C. M. JONES. Acid and base secretions by the stomach; reference of pain from the gastro-intestinal tract.

WARREN MUSEUM

Open daily from 2 to 4 p.m.

Demonstrations by DR. M. CANAVAN, Curator

Dwight collection of spines illustrating deformities, anomalies, diseases.

Bone tumors, with X-ray, histories, and microscopic slides and microscopes available for examination. Some of these specimens were used in the illustrations in the monograph on "Bone Sarcoma" issued by the American College of Surgeons.

Models showing various types of club feet and effects of operation.

The pictures in Dr. Nichols' collection illustrating pathological conditions of bone.

Fractures and dislocations of bones as they existed before industrial plants provided so many safeguards.

Tuberculosis of bones and joints.

Syphilis of bones.

Dislocation of ends of bones.

Collection of old surgical instruments, obstetrical forceps, turn keys for extracting teeth, urological tools, cupping and leeching instruments.

ROBERT BRIGHAM HOSPITAL

Tuesday

H. A. NISSEN—2. Focal infection in chronic arthritis; gastro-intestinal studies.

L. T. SWAIM—3. Types of arthritis with X-ray studies and orthopedic principles in the treatment.

Wednesday

P. D. WILSON—2. Operation for knee deformities.

L. T. SWAIM—3. Demonstration of orthopedic apparatus.

Thursday

L. M. SPEAR—2. Circulatory conditions in arthritis.

L. T. BROWN—3. Mechanical conditions of the low back.

Friday

P. D. WILSON—2. Orthopedic operations and demonstration of cases; orthopedic principles in the treatment of chronic arthritis.

CLINICS ON INDUSTRIAL SURGERY

At these clinics, to be held in the office of the Medical Director of the American Mutual Liability Insurance Company, cases will be shown to illustrate diagnosis, treatment and end-results.

Tuesday

ERNEST A. CODMAN—2. Shoulder injuries.

EDWARD L. YOUNG—4. Inguinal pain without hernia.

Wednesday

P. D. WILSON—2. Fractures of the os calcis; injuries to the knee.

RUDOLPH JACOBY—4. Industrial dermatology.

Thursday

FRED J. COTTON—2. Reconstruction surgery in industry

JOHN D. ADAMS—4. Injuries to the back.

Friday

JOHN D. HODGSON—2. Fracture of the skull.

HARRY C. SOLOMON—3. Industrial neurology.

HENRY C. MARBLE—4. Hernia.

MASSACHUSETTS HOMEOPATHIC HOSPITAL

Monday

T. E. CHANDLER and H. J. LEE—2. General surgical clinic: Operations and demonstration of cases.

Tuesday

C. T. HOWARD and C. CRANE—9. Surgical operations.

R. C. WIGGIN and S. N. VOSE—9. Urological operations.

S. W. ELLSWORTH—10. X-ray demonstration.

S. R. MEAKER—10. Gynecological clinic.

J. E. BRIGGS and W. K. S. THOMAS—2. General surgica operations.

Wednesday

T. E. CHANDLER and C. D. HARVEY—9. Surgical operations.

A. G. HOWARD, S. L. MARNOY and L. G. HOWARD—9. Orthopedic operations.

C. T. HOWARD and H. J. LEE—2. Surgical operations.

L. F. JOHNSON—2. Bronchoscopic clinic.

Thursday

J. E. BRIGGS and C. CRANE—9. Surgical operations.

S. R. MEAKER—10. Gynecological clinic.

S. W. ELLSWORTH—10. X-ray demonstration.

C. T. HOWARD and W. K. S. THOMAS—2. Surgical operations.

Friday

T. E. CHANDLER and C. CRANE—9. Surgical operations.

J. E. BRIGGS and H. J. LEE—2. Surgical operations.

BOSTON DISPENSARY

Tuesday

H. J. INGLIS—2. Lipiodol injections in the diagnosis of bronchiectasis and lung abscess as used in out-patient department.

ARTHUR H. CROSBIE and HAROLD CHAMBERLAIN—2. Cystoscopy and demonstration of cases.

JOSEPH H. PRATT—2. Dry clinic, importance of the physician to the surgeon, illustrated by cases.

Wednesday

JOHN D. ADAMS—11. Orthopedic operations.

HILBERT F. DAY—11. Injection treatment of varicose veins; demonstration of technique, cases and pathological specimens.

HARRY FRIEDMAN—11. Demonstration of malignancies treated by radium and X-ray therapy.

Thursday

A. K. PAINE—2. Treatment of gonorrhœa in women.

WILLIAM A. HINTON—2. Hinton-cholesterol reaction; demonstration of technique and relative sensibility.

MAYNARD LADD—2. Surgical aspects of pyloric stenosis in infants.

CAMBRIDGE HOSPITAL

Tuesday

Staff—9. General surgical clinics, operations and demonstration of cases.

Wednesday

J. W. SEVER and F. A. FINDLAY—9. Orthopedic clinic, operations and demonstration of cases.

Friday

Staff—9. General surgical clinics, operations and demonstration of cases.

ST. ELIZABETH'S HOSPITAL

Tuesday

G. F. KEENAN—9. Surgical clinic; Appendectomy; hysterectomy.
JOSEPH STANTON—9. Surgical clinic: Thyroid cases; gastro-enterostomy.
W. F. DOLAN—9. Surgical clinic: Inguinal hernia.
C. J. KICKHAM—9. Prolapse of uterus.
F. T. JANTZEN—9. Inguinal hernia under local anæsthesia.
H. S. ROWEN—9. Appendectomy.
A. L. CHUTE and B. D. WETHERELL—2. Dry clinic; Genito-urinary cases, end-results and unusual roentgenograms.
T. J. SCANLAN—2. Gynecological examinations.
PIERCE DUNPHY—2. Cases of cancer of cervix; operation and X-ray therapy, one to four years after operation.
PIERCE MCGANN—2. Postoperative hypospadias.

Wednesday

F. T. JANTZEN—9. Surgical clinic: Appendectomy; cholecystectomy.
G. F. KEENAN—9. Surgical clinic: Cholecystectomy.
PIERCE DUNPHY—9. Perineal plastic; cæsarean section.
JOSEPH STANTON—9. Thyroid cases.
R. SULLIVAN—9. Knee cartilage.
T. F. BRODERICK—9. Reconstruction of hip; plastic on knee joint.
T. F. BRODERICK and R. F. SULLIVAN—2. Dry clinic: End-results in spinal fusion for tuberculosis, scoliosis, and anatomical anomalies; end-results in plastic cases for relief of deformity.
F. T. JANTZEN—2. End-results in fractures, operative and non-operative; colloidal lead treatment for malignant diseases.
DR. HEALEY—2. Interesting roentgenograms.
JOHN DUNPHY—2. Surgical aspects of pediatrics.

Thursday

T. F. BRODERICK—9. Surgical clinic: Spinal fusion.
A. L. CHUTE—9. Prostatectomy; tumor of bladder; nephrectomy.
JOSEPH STANTON—9. Gastro-enterestomy; cholecystectomy; appendectomy.
H. S. ROWEN—9. Hysterectomy.
G. F. KEENAN—9. Ovarian cyst.
A. H. CROSBIE—9. Nephrectomy.
JOSEPH STANTON—2. Dry clinic: Hour-glass stomach; fibroma of colon, with intermittent intussusception; carcinoma of appendix.
J. J. SULLIVAN—2. Toxæmia following administration of alkalies for treatment of duodenal ulcer.
L. J. LOUIS—2. Postoperative pancreatic cyst.
H. S. ROWEN—2. Surgical cases.

Friday

L. J. LOUIS—9. Surgical clinic: Appendectomy; cholecystectomy.
H. S. ROWEN—9. Cholecystectomy.
JOSEPH STANTON—9. Appendectomy; hysterectomy.
G. F. KEENAN—9. Ventral hernia; appendectomy.
C. J. KICKHAM—9. Cæsarean section.
F. T. JANTZEN—9. Inguinal hernia under local anæsthesia.
G. F. KEENAN—2. Dry clinic: Postoperative fracture of skull; postoperative extensive resection of chest.
M. H. SPELLMAN—2. End-results in fractures of skull.

TUFTS COLLEGE MEDICAL SCHOOL

TIMOTHY LEARY—2, daily. Demonstration of specimens illustrating results of traumatism, especially cranial and cerebral.

LONG ISLAND HOSPITAL

Monday

J. H. CUNNINGHAM and C. S. SWAN—2. Genito-urinary clinic, operations and demonstration of cases.
CHARLES LUND—2. The use of surgical diathermy in cancer of the tongue and mouth.
LAWRENCE W. SMITH—2. Surgical pathology.
H. R. VIETS—2. Neurosurgical features pertaining to surgery.
A. B. MACMILLAN—2. Surgical X-ray demonstration.

Wednesday

ROBERT SOUTTER—2. Orthopedic clinic, operations and demonstration of cases; traction in the treatment of fractures; treatment of congenital hip.
LAWRENCE SMITH—2. Surgical pathology.
H. R. VIETS—2. Neurosurgical features pertaining to surgery.
A. B. MACMILLAN—2. Surgical X-ray demonstration.
CHARLES LUND—2. Injection treatment of varicose veins; operations and demonstration of cases.

Friday

J. H. CUNNINGHAM and C. S. SWAN—2. Genito-urinary operations.
ROBERT SOUTTER—2. Orthopedic operations.
CHARLES LUND—2. General surgical operations.
LAWRENCE SMITH—2. Surgical pathology.
H. R. VIETS—2. Neurosurgical features pertaining to surgery.
A. B. MACMILLAN—2. Surgical X-ray demonstration.

NEW ENGLAND HOSPITAL FOR WOMEN AND CHILDREN

Tuesday

L. D. ADAMS, B. L. ATWOOD and GRACE ROCHFORD—9. Gynecological operations.
B. L. ATWOOD, E. MACNAUGHTON, MARION NUTE—9. Cæsarean section; operative deliveries if available.

Wednesday

MARION NUTE—9. Demonstration of unusual obstetrical cases; nursery and ward walk; prenatal clinic.
L. D. ADAMS, B. L. ATWOOD and GRACE ROCHFORD—9. Gynecological operations.

Thursday

GRACE ROCHFORD and OLGA LEARY—9. Demonstration of postoperative cases; pathological specimens.
EVELINE B. LYLE and E. WRIGHT—9. Demonstration of border-line cases.

BETH ISRAEL HOSPITAL

WYMAN WHITTEMORE and associates—9, daily. General surgical clinic.
E. G. CRABTREE—9, daily. Urological clinic.
MARK ROGERS—9, daily. Orthopedic clinic.
HERMAN BLUMGARD. Demonstration in medical research department.

BOSTON UNIVERSITY SCHOOL OF MEDICINE
(Evans Memorial Building)

S. R. MEAKER and A. W. ROWE—2, Wednesday and Friday. Studies in sterility.
A. W. ROWE and C. H. LAWRENCE—2, Wednesday and Friday. Endocrinology.

SURGERY OF THE EYE, EAR, NOSE, AND THROAT

CLINICAL DEMONSTRATIONS

Tuesday, 2 P.M.—Georgian Room, Statler Hotel

J. M. WHEELER, M.D., New York, and GEORGE S. DERBY, M.D., Boston: Our Mistakes in Ophthalmology.
C. B. FAUNCE, M.D., Boston: Brain Abscess Cases; Lipiodol Injections in Brain Abscess.
H. P. CAHILL, M.D., Boston: Report of a Case of Cerebellar Abscess.
D. C. SMYTH, M.D., Boston: Lipiodol Injections in Lung Abscess.
E. W. HERMAN, M.D., Boston: Two Cases of Foreign Body in the Tracheo-Œsophageal Wall.

Wednesday, 2 P.M.—Georgian Room, Statler Hotel

Presentation of manual dealing with minimum requirements for general hospitals caring for ophthalmological, rhinological and otolaryngological patients. See detailed program under "Hospital Conference."

Thursday, 2 P.M.—Georgian Room, Statler Hotel

D. H. WALKER, M.D., Boston: Lip Reading and the Deaf Child; Aids to Hearing.
C. D. KNOWLTON, M.D., Boston: Animal Studies in the Regeneration of the Antral Mucous Membrane.
L. A. SCHALL, M.D., Boston: Microscopic slides illustrating pathologic conditions of the antrum.
D. W. DRURY, M.D., Boston: The Results of Metabolism Tests in Cases of Chronic Deafness.
T. B. HOLLOWAY, M.D., Philadelphia. Optic Relations at the Base of the Skull.
F. H. VERHOEFF, M.D., Boston: Ophthalmic Pathology.

Friday, 2 P.M.—Georgian Room, Statler Hotel

J. H. WAITE, M.D., Boston: Diagnosis in Glaucoma.
W. B. LANCASTER, M.D., Boston: Operation vs. Miotics.
A. GREENWOOD, M.D., Boston: Handling of Secondary Glaucoma.
H. P. CAHILL, M.D., Boston: Lantern slide demonstration of serial sections of the ear.
F. E. GARLAND, M.D., Boston: Infection of the Submaxillary Gland; Discussion of Treatment.
V. H. KAZANJIAN, M.D., Boston: Plastic Operations on the Tip of the Nose.
H. P. MOSHER, M.D., Boston: Report of a Case of Cavernous Sinus Thrombosis; Description of Operation, Autopsy Findings (Microscopical slides showing the pathological findings in both eyes).

MASSACHUSETTS EYE AND EAR INFIRMARY

Tuesday

Ophthalmology

Staff—9. Operations and demonstrations of cases.
J. M. WHEELER. Plastic surgery.
G. S. DERBY. Eye operations.
W. H. LOWELL. Muscles.
J. H. WAITE. Slit-lamp demonstration.
E. B. DUNPHY. External diseases.
R. C. CHENEY. Perimetry.
H. K. MESSENGER. Physiologic optics.
P. A. CHANDLER. Light sense.
T. L. TERRY. Pathology.
IDA E. RIDGEWAY. Sight-saving class.

Otolaryngology

PHILIP HAMMOND—9. Simple and radical mastoid operation.
H. A. BARNES—9. Dry clinic: Malignant diseases of the accessory sinuses, exhibition of patients.
H. P. CAHILL—10. Dry clinic: Wire gauze brain drain; paraffin basket for skin graft of radical mastoid cavity; lantern slides of brain cases.
G. H. TOBEY—11. Dry clinic: Lateral sinus thrombosis; the manometer test.
C. B. FAUNCE—2. Dry clinic: Lipiodol injections in brain abscess.
D. C. SMYTH—3. Dry clinic: Lipiodol injections in lung abscess.

Wednesday

Otolaryngology

G. H. POIRIER—9. Mosher-Toti lachrymal sac operation.
F. A. SIMMONS—10. Tonsillectomy cases, dissection and snare.
G. H. POIRIER. Sluder technique.
H. P. CAHILL. LaForce technique.
P. E. MELTZER. Removal with cautery snare.
A. S. MACMILLAN—11. Dry clinic: Demonstration of accessory sinus and mastoid X-rays.

Ophthalmology

Staff—9. Operations and demonstrations of cases.
W. B. LANCASTER. Eye operations.
J. B. AYER and G. S. DERBY. Nerve-eye clinic.
MAUDE CARVILL. Ocular tuberculosis.
J. H. WAITE. Gullstrand ophthalmoscope.
P. A. CHANDLER. Perimetry.
B. SACHS. External diseases.
H. K. MESSENGER. Physiologic optics.
P. A. CHANDLER. Light sense.
T. L. TERRY. Pathology.
IDA E. RIDGEWAY. Sight-saving class.

Thursday

Otolaryngology

V. H. KAZANJIAN—9. Plastic operations.
D. C. SMYTH—9. Dry clinic: Fluoroscope and removal of metallic foreign bodies.
H. P. MOSHER—10. Dry clinic: Exhibition of œsophageal instruments; demonstration of fluoroscopic examination of the œsophagus.
A. S. MACMILLAN—11. Dry clinic: Lantern slide demonstration of œsophageal cases.
DR. KIRBY—2. Demonstration of Bárány tests.
F. E. GARLAND—3. Dry clinic: Infection of the submaxillary gland.

Ophthalmology

Staff—9. Operations and demonstrations of cases.
T. B. HOLLOWAY. Thyroid-eye cases.
A. GREENWOOD. Eye operations.
S. J. BEACH. Refraction with angular type.
W. B. LANCASTER. Muscles.
H. B. C. RIEMER. External diseases.
E. B. DUNPHY. Perimetry.
H. K. MESSENGER. Physiologic optics.
P. A. CHANDLER. Light sense.
T. L. TERRY. Pathology.
IDA E. RIDGEWAY. Sight-saving class.

Friday

Ophthalmology

Staff—9. Operations and demonstrations of cases.
F. H. VERHOEFF. Eye operations.
H. B. C. RIEMER. Tear sac cases: congenital, acute, chronic.
AMY SMITH. Social work.
H. K. MESSENGER. Physiologic optics.
P. A. CHANDLER. Light sense.
T. L. TERRY. Pathology.
IDA E. RIDGEWAY. Sight-saving class.

Otolaryngology

V. H. KAZANJIAN—9. Dry clinic: Correction of deformities of the face and nose, lantern slide demonstration.
H. P. MOSHER—10. Dry clinic: Punch tracheotomy.
A. S. MACMILLAN. X-ray of thymus (lantern slides).
F. E. GARLAND—11. Historical exhibit of laryngeal instruments.
H. P. CAHILL—2. Dry clinic: Lantern slide demonstration of serial sections of the ear.
D. H. WALKER—3. Dry clinic: Lip reading and the deaf child.

CARNEY HOSPITAL

Tuesday

W. S. LIEBMAN—9. Eye operations and demonstration of cases; X-ray localization and magnet extraction of foreign bodies.

Wednesday

E. D. HURLEY and W. S. LIEBMAN—9. Eye operations and demonstration of cases.

Thursday

W. S. LIEBMAN and H. BORNCHOFF—9. Eye operations and demonstration of cases.

Friday

W. J. SHEEHAN and F. G. MINITER—2. Otolaryngological clinic.

MASSACHUSETTS HOMEOPATHIC HOSPITAL

Tuesday

W. D. ROWLAND—9. Eye clinic.
F. W. COLBURN and H. L. BABCOCK—9. Aural clinic.

Thursday

W. D. ROWLAND—9. Eye clinic.
C. SMITH, C. W. BUSH, E. R. JOHNSON, R. O. PARRIS and W. W. WALKER—9. Nose and throat clinic.

Friday

W. D. ROWLAND, J. E. STERNBERG, H. M. EMMONS and J. J. SKIRBALL—9. Eye clinic.

HARVARD MEDICAL SCHOOL

Monday

H. P. MOSHER—2. Laryngological demonstration: Casts of the adult œsophagus; wet specimens showing the œsophagus at birth; cadaver demonstration of the Mosher-Toti lachrymal sac operation; teaching methods used in post-graduate instruction in laryngology.

Tuesday

G. S. DERBY—2. Ophthalmological demonstrations: Active research, demonstrations of what the pathological laboratory is doing and has done in the past; demonstration of work on the light sense; teaching of physiologic optics.
DRS. VERHOEFF and TERRY. Demonstration of pathological slides.
DRS. DERBY, CHANDLER and MISS O'BRIEN. Significance of the light sense, and a demonstration of the methods by which it may be tested.
LUCIEN HOWE—2. Ophthalmic ergograph, writes automatically the story of ocular fatigue and relation of this fatigue to "eye strain."
H. P. MOSHER—2. Mosher-Toti lachrymal sac operation; demonstration on cadaver.
P. E. MELTZER. Anatomical exhibit of temporal bone specimens.

Wednesday

H. P. MOSHER—2. Laryngological demonstration: Casts of the adult œsophagus; wet specimens showing the œsophagus at birth; cadaver demonstration of the Mosher-Toti lachrymal sac operation; teaching methods used in post-graduate instruction in laryngology.
C. B. FAUNCE—2. Exhibition of temporal bone specimens.

Thursday

G. S. DERBY—2. Ophthalmological demonstrations: Active research, demonstrations of what the pathological laboratory is doing and has done in the past; demonstration of work on the light sense; teaching of physiologic optics.
DRS. VERHOEFF and TERRY. Demonstration of pathological slides.
DRS. DERBY, CHANDLER and MISS O'BRIEN. Significance of the light sense, and a demonstration of the methods by which it may be tested.
LUCIEN HOWE—2. Ophthalmic ergograph, writes automatically the story of ocular fatigue and relation of this fatigue to "eye strain."
H. P. MOSHER—2. Demonstration of methods in post-graduate teaching of laryngology.
M. H. LURIE—3. Exhibition of temporal bone specimens.

BOSTON DISPENSARY

Tuesday

H. J. Inglis—2. Beck-Schenk snare method of tonsillectomy.

Wednesday

Joseph J. Skirball—11. Eye clinic, demonstration of cases, external diseases, perimetry, ophthalmological co-operation with syphilis clinic.

ST. ELIZABETH'S HOSPITAL

Tuesday

W. T. Haley—9. Mastoid and tonsil cases

Wednesday

P. S. McAdams—9. Enucleation of the eye.
J. Burns—9. Tonsillectomy.

Friday

W. T. Haley—9. Frontal sinus operation.
J. Burns—9. Mastoid operation.
W. T. Haley—2. End-results in radical sinus operations.

CAMBRIDGE HOSPITAL

N. S. Bacon and E. J. Butler—9, Thursday. Nose and throat clinic.

NEW ENGLAND HOSPITAL FOR WOMEN AND CHILDREN

M. N. Kleinert and I. D. Kerr—9, Tuesday and Wednesday. Ear, nose, and throat clinic; operations and demonstration of cases.

BETH ISRAEL HOSPITAL

L. V. Friedman and L. Arkin—9, daily. Nose and throat clinic.

BOSTON CITY HOSPITAL

J. J. Corbett—9, daily. Eye clinic.

CARNEY HOSPITAL

E. D. Hurley—9, daily. Eye clinic.

ANNUAL HOSPITAL STANDARDIZATION CONFERENCE

Monday, 10:00—Ballroom, Copley-Plaza Hotel

GEORGE D. STEWART, M.D., New York, Presiding

Address of Welcome. FREDERIC A. WASHBURN, M.D., Boston; Director, Massachusetts General Hospital.

The Rôle of the American College of Surgeons in Improving Hospital Service. GEORGE D. STEWART, M.D., New York, President, American College of Surgeons.

Presentation of Annual Report of Hospital Standardization and Announcement of Approved List for 1928. M. T. MACEACHERN, M.D., Chicago; Associate Director, American College of Surgeons and Director of Hospital Activities.

Health Inventoriums in Approved Hospitals—Further Progress of Research. FRANKLIN H. MARTIN, M.D., Chicago; Director-General, American College of Surgeons.

The Interest and Influence of the Duke Endowment in Hospital Standardization. W. S. RANKIN, M.D., Charlotte, N. C.; Director, The Duke Endowment.

Nurses, Patients and Pocketbooks. MAY AYRES BURGESS, Ph.D., New York; Director, Committee on the Grading of Nursing Schools.

General Discussion. WILLIAM DARRACH, M.D., New York; Dean, College of Physicians and Surgeons, Columbia University; and MARY M. ROBERTS, R.N., New York; Editor, American Journal of Nursing.

Monday, 2:00—Ballroom, Copley-Plaza Hotel

GEORGE D. STEWART, M.D., New York, Presiding

Missed Pedagogic Opportunities Incident to the Usual Organization of the Resident Medical Staff of the Hospital. HENRY A. CHRISTIAN, M.D., Boston; Hersey Professor Theory and Practice of Physic, Harvard University Medical School.

Medical Education and Specialization. WILLARD C. RAPPLEYE, M.D., New Haven; Director of Study, Commission on Medical Education.

Experimental Science versus Imitative Art in Medicine. MURRAY BLAIR, M.D., Vancouver, B. C.

What Is the Rôle of the Hospital Administrator? F. E. CHAPMAN, Cleveland; Director, Mt. Sinai Hospital.

Visual Methods in Conducting the Staff Conference (Illustrated). C. G. PARNALL, M.D., Rochester, N. Y.; Director, Rochester General Hospital; President-elect, American Hospital Association; and HARRY D. CLOUGH, M.D., Rochester, N. Y.; Assistant Medical Director, Rochester General Hospital.

General Discussion. CHARLES H. YOUNG, M.D., Portland, Maine; Director, Maine General Hospital; and JOHN T. BURRUS, M.D., High Point, N. C.; Surgeon, High Point Hospital.

Tuesday, 9:30—Ballroom, Copley-Plaza Hotel

JOSEPH B. HOWLAND, M.D., Boston; Superintendent, Peter Bent Brigham Hospital, Presiding.

The Educational and Economic Value of the Outpatient Department in a General Hospital. JAMES RAGLAN MILLER, M.D., Hartford; Assistant Gynecologist and Obstetrician, Hartford Hospital.

Selective Economic Basis for Outpatient Service (Illustrated). BEATRICE KAISER, Detroit; Clinic Executive, Harper Hospital.

Minimum Standards for the Hospital Social Service Department. MABEL R. WILSON, R.N., Boston; Director Social Service Department, Children's Hospital.

The Operation of a Physical Therapy Department from the Scientific and Economic Standpoints. JOHN S. COULTER, M.D., Chicago; Assistant Professor of Physical Therapy, Northwestern University Medical School.

Discussion. MICHAEL M. DAVIS, Ph.D., New York; Executive Secretary, Committee on Dispensary Development, United Hospital Fund of New York; and FRANK GRANGER, M.D., Boston; Director of Physical Therapy Department, Boston City Hospital.

Tuesday, 2:00—Ballroom, Copley-Plaza Hotel

Clinic on Case Records in Hospitals. Directed by C. W. MUNGER, M.D., Valhalla, N. Y.; Director, Grasslands Hospital.

What Constitutes a Good Case Record? ERNEST LEROI HUNT, M.D., Worcester; Surgeon and Director of Surgical Services, Worcester City Hospital.

What Are the Best Methods of Appraising Case Records? HAROLD W. HERSEY, M.D., Bridgeport; Superintendent, Bridgeport Hospital.

What Part Should the Record Librarian Play in Promoting Efficient Case Records in the Hospital? GRACE W. MYERS, Boston; Librarian Emeritus, Massachusetts General Hospital.

How Best Can Good Case Records Be Maintained in the Small Hospital Where the Usual Difficulties—Lack of Internes, Shortage of Funds, and No Historian or Record Librarian—Are Frequently Found? CLARA A. DOOLITTLE, Derby, Conn.; Historian, Griffin Hospital, and President, Connecticut Hospital Historians Association.

What Are the Most Effective Ways and Means of Stimulating Good Case Records? EMMA C. BLACK, New Haven Record Librarian, Grace Hospital.

What Should Be the Functions of a Record Committee of the Medical Staff? E. W. WILLIAMSON, M.D., Chicago; Chief Field Representative, American College of Surgeons.

What Are the Most Effective Means of Keeping Current Case Records up to Date? R. C. BUERKI, M.D., Madison; Superintendent, Wisconsin General Hospital.

What Are the Relative Advantages or Disadvantages of the Various Filing Systems? EDITH M. ROBBINS, Boston; Chief Record Librarian, Peter Bent Brigham Hospital.

The Organization and Functioning of a Central Record Department. GENEVIEVE CHASE, Boston; Record Librarian, Massachusetts General Hospital.

Wednesday, 9:30—Ballroom, Copley-Plaza Hotel

Open Forum—Problems Involved in the Professional Care of the Patient. Directed by LEWIS A. SEXTON, M.D., Hartford; Superintendent, Hartford Hospital.

Measuring the Professional Efficiency of the Hospital. JOSEPH C. DOANE, M.D., Philadelphia, Superintendent, Philadelphia General Hospital.

Standard of Surgical Efficiency. GEORGE W. SWIFT, M.D., Seattle; Surgeon, Children's Orthopedic and King County Hospitals.

Medical Staff Organization. T. T. MURRAY, Albany; Superintendent, Memorial Hospital.

Relation of the Clinical Pathologist to the Medical Staff and the Scientific Work of the Hospital. J. J. MOORE, M.D., Chicago; Director, National Pathological Laboratory.

Responsibility of Hospital Trustees for the Professional Care of the Patient. JOSEPH J. WEBER, New Haven; Superintendent, Grace Hospital.

Follow-Up. FRANK E. WING, Boston; Director, Boston Dispensary.

Appraisal of Nursing Service. MIRIAM CURTIS, Northampton; Superintendent, Cooley-Dickinson Hospital.

The Clinico-Pathological Conference as an Educational Factor in the Hospital. JOHN E. RANSOM, Toledo; Superintendent, Toledo Hospital

Wednesday, 2:00—Georgian Room, Statler Hotel

GEORGE S. DERBY, M.D., Boston; Professor of Ophthalmology, Harvard University, Medical School, Presiding.

Presentation of Manual Dealing with Minimum Requirements for General Hospitals Caring for Ophthalmological, Rhinological, and Oto-Laryngological Patients. JOSEPH C. BECK, M.D., Chicago; Associate Professor of Oto-Laryngology, University of Illinois College of Medicine.

Discussion. ROBERT C. LYNCH, M.D., New Orleans; Professor of Oto-Laryngology, Tulane University of Louisiana Post-Graduate School of Medicine.

Round Table Conference—Every-Day Problems as Related to the Care of Ophthalmological, Rhinological, and Oto-Laryngological Patients in General Hospitals. Directed by PERRY G. GOLDSMITH, M.D., Toronto; Professor of Oto-Laryngology, University of Toronto Faculty of Medicine.

Should All Internes Receive Practical Experience in the Eye, Ear, Nose and Throat Department? HORACE J. WHITACRE, M.D., Tacoma, Wash.; Surgeon, General Hospital.

Should All Student Nurses Receive Practical Experience in the Eye, Ear, Nose and Throat Department? If So, to What Extent? GRACE E. ALLISON, Troy, N. Y.; Superintendent, Samaritan Hospital.

Is It Advisable and Practical to Standardize Routine Procedures as well as Dressings and Supplies Pertaining to the Work of these Specialties? WALTER H. SNYDER, M.D., Toledo; Ophthalmologist and Chief of Staff, Flower Hospital.

How Can an Efficient Anæsthesia Service Be Maintained for the Eye, Ear, Nose and Throat Department? FREEMAN ALLEN, M.D., Boston; Anæsthetist, Massachusetts Eye and Ear Infirmary.

In the Absence of the Attending Doctor and When There Is No Interne or Resident What Emergency Measures Can the Hospital Personnel Carry out in Case of Hæmorrhage following Tonsillectomy, or other Accidents Which Might Follow in the Work of these Specialties? JOHN O. MCREYNOLDS, M.D., Dallas; Ophthalmic and Aural Surgeon, St. Paul's Sanitarium.

How Long, on the Average, Should Tonsil Cases Be in the Hospital Pre- and Postoperative? Should All Cases of Discharging Ears or Sinuses of Unknown Origin Be Segregated from Other Patients? WILLIAM ARRELL, M.D., Hamilton, Ontario; Visiting Surgeon, Hamilton General Hospital.

When Building a Hospital Should the Operating Rooms for the Eye, Ear, Nose and Throat Department Be Located in the General Surgery Suite or in the Department with the Wards? DAVID H. BALLON, M.D., Montreal; Demonstrator in Oto-Laryngology, McGill University Faculty of Medicine.

What Routine Laboratory Examinations Should Be Required in the Work of the Eye, Ear, Nose and Throat Department? SHIELDS WARREN, M.D., Boston; Pathologist, New England Deaconess Hospital.

Wednesday, 2:00—Ballroom, Copley-Plaza Hotel

Open Forum—The Small Hospital and Hospital Standardization. Directed by PAUL FESLER, Minneapolis; Superintendent, University Hospitals.

What the Duke Endowment Is Doing for the Small Hospital. HUBERT A. ROYSTER, M.D., Raleigh, N. C.; Surgeon, Rex and St. Agnes Hospitals.

How the Large Hospital Can Assist the Small Hospital in Complying with the Requirements. ROBERT M. HARBIN, M.D., Rome, Georgia; Surgeon, Harbin Hospital.

How the Medical Staff of the Small Hospital Can Be Organized and Function so as to Meet the Requirements. LOUIS G. PINAULT, M.D., Campbellton, N. B.; Chief Surgeon, Hotel Dieu of St. Joseph.

How the Small Hospital Can Maintain a Record System Acceptable to the American College of Surgeons. MINNIE GENEVIEVE MORSE, Plainfield, N. J.

How the Small Hospital Can Build up the Essential Special Services to a Degree Acceptable for Approval. LUCY ABBOTT, Norwich, Conn.; Superintendent, William W. Backus Memorial Hospital.

General Discussion. T. E. REEKS, M.D., New Britain, Conn.; Superintendent, New Britain General Hospital; RUTH A. BROWN, Wyandotte, Mich.; Superintendent, Wyandotte General Hospital, and W. S. RANKIN, M.D., Charlotte, N. C.; Director, the Duke Endowment.

Thursday, 9:30— Ballroom, Copley-Plaza Hotel

FULLER F. BARNES, Bristol, Conn.; President, Board of Directors, Bristol Hospital, Presiding.

The Care of Obstetrical Patients in General Hospitals. JAMES F. TAYLOR, M.D., Sioux City; Member of Staff, St. Vincent's Methodist and Sioux City Maternity Hospitals.

The Care of the Convalescent Patient. JOHN BRYANT, M.D., Boston.

The Responsibility of the Hospital Administration in the Care of Fractures. CHARLES L. SCUDDER, M.D., Boston; Consulting Surgeon, Massachusetts General Hospital.

The Responsibility of the Hospital Administration in the Care of the Injured. FREDERIC A. BESLEY, M.D., Waukegan, Ill.; Professor of Surgery, Northwestern University Medical School.

Possibility of Postoperative Infections from Contamination of Water in Hospitals. ARNOLD H. KEGEL, M.D., Commissioner of Health, City of Chicago.

Beauty in the Hospital. REV. C. B. MOULINIER, S.J., Milwaukee; Executive Director, Catholic Hospital Association.